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TISSUE REMOVAL DEVICE WITH TISSUE GRIP

(75)

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Field of Classification Search

USPC 606/79, 80, 83, 169, 170–180
See application file for complete search history.

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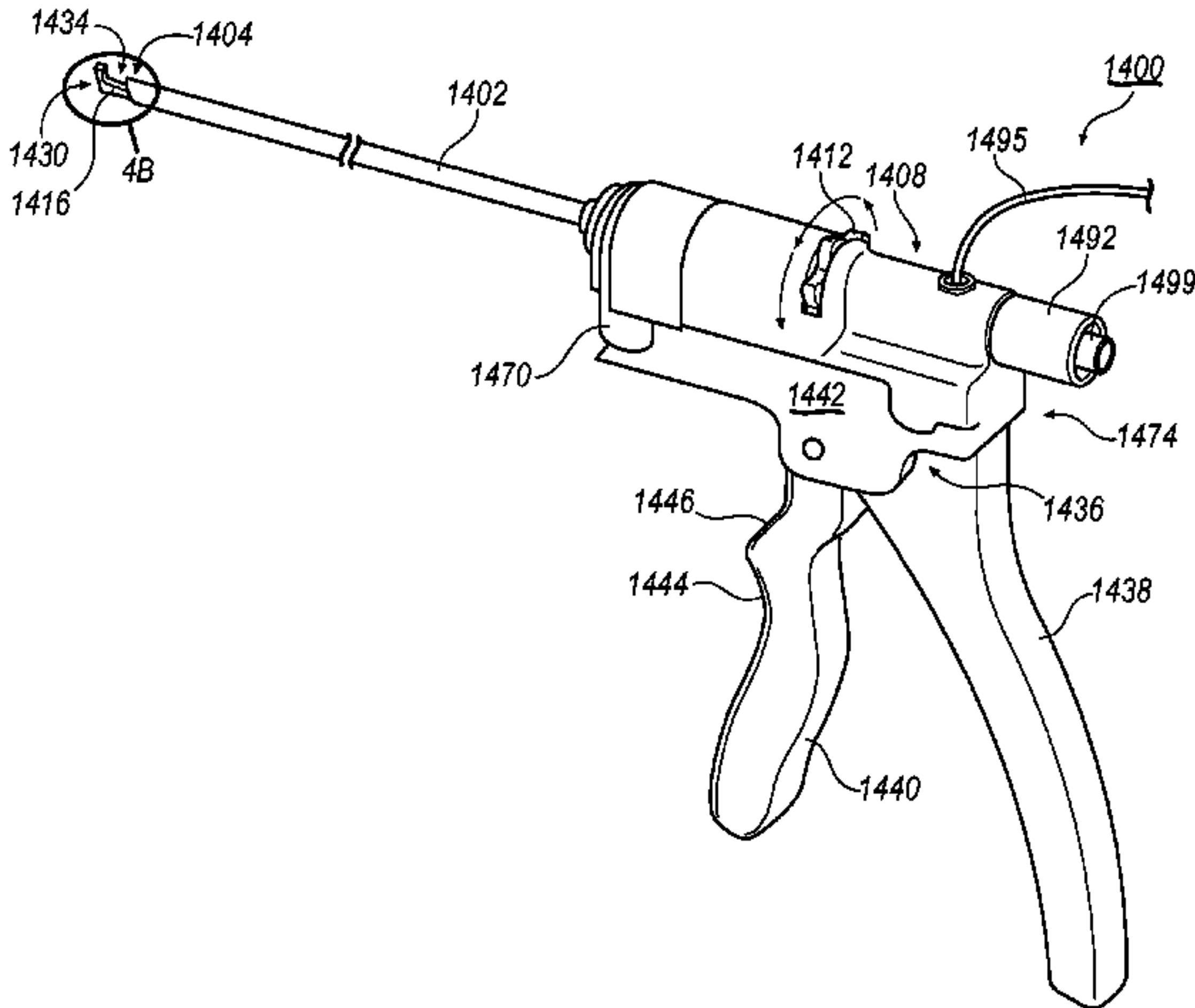
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(57) ABSTRACT

A tissue removal device is disclosed. In one arrangement, the tissue removal device includes a cutting member operatively connected to an actuator assembly and a fixed member. The cutting member is configured to slide with respect to the fixed member in a reciprocating manner. The fixed member includes an upwardly extending foot plate that defines a contact surface that is configured with an uneven texture that serves as a grip to operatively retain material to be cut when the cutting member is moved toward the foot plate.

29 Claims, 11 Drawing Sheets



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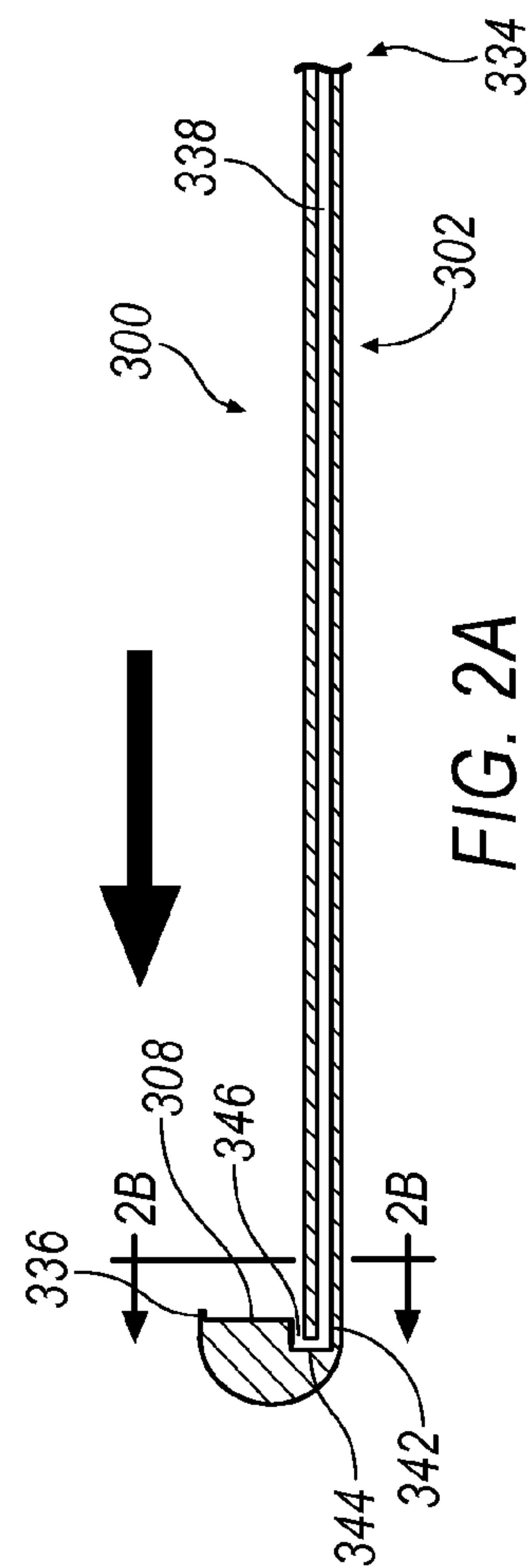
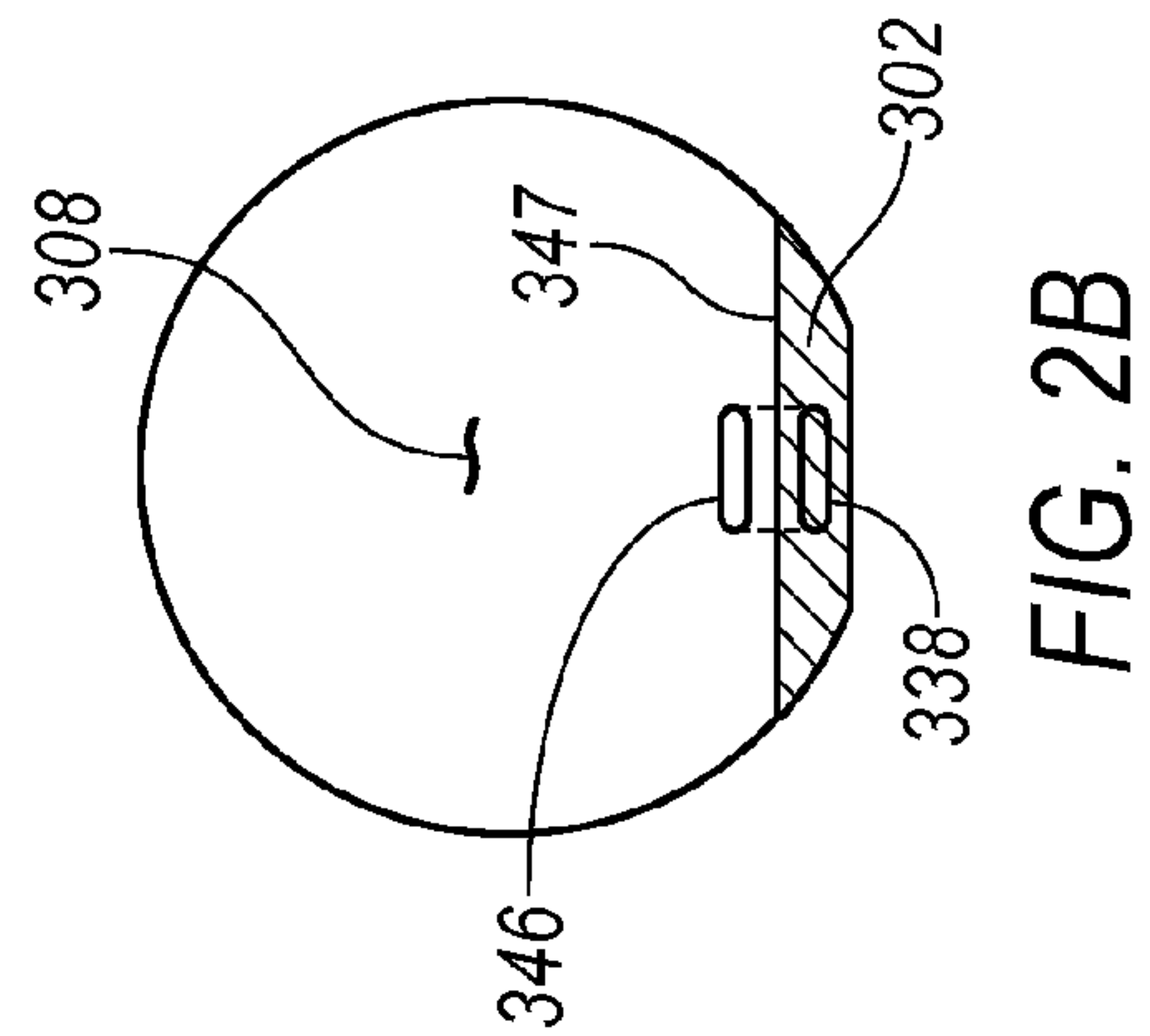
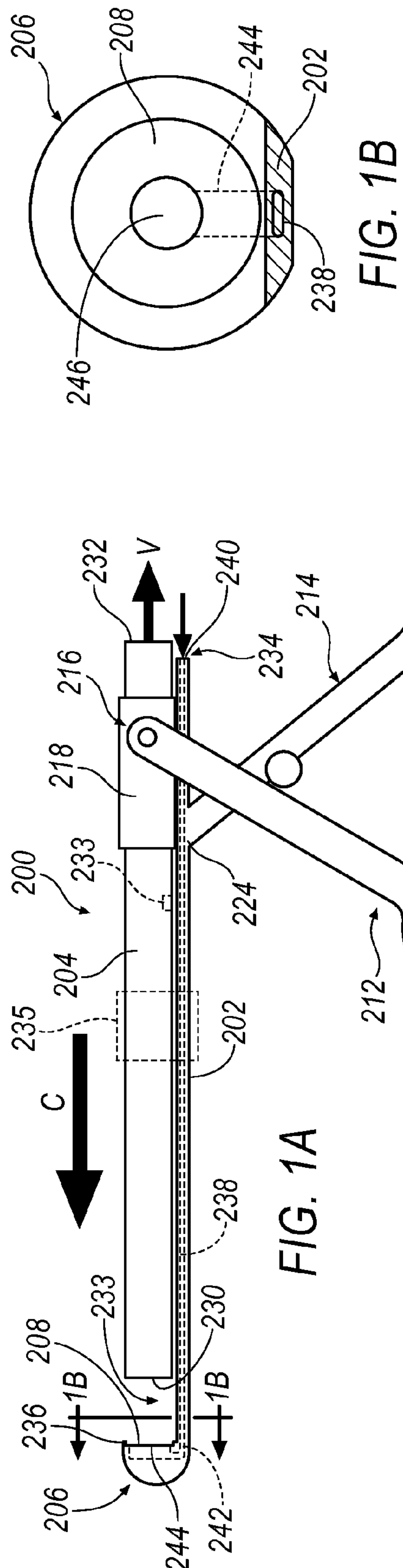
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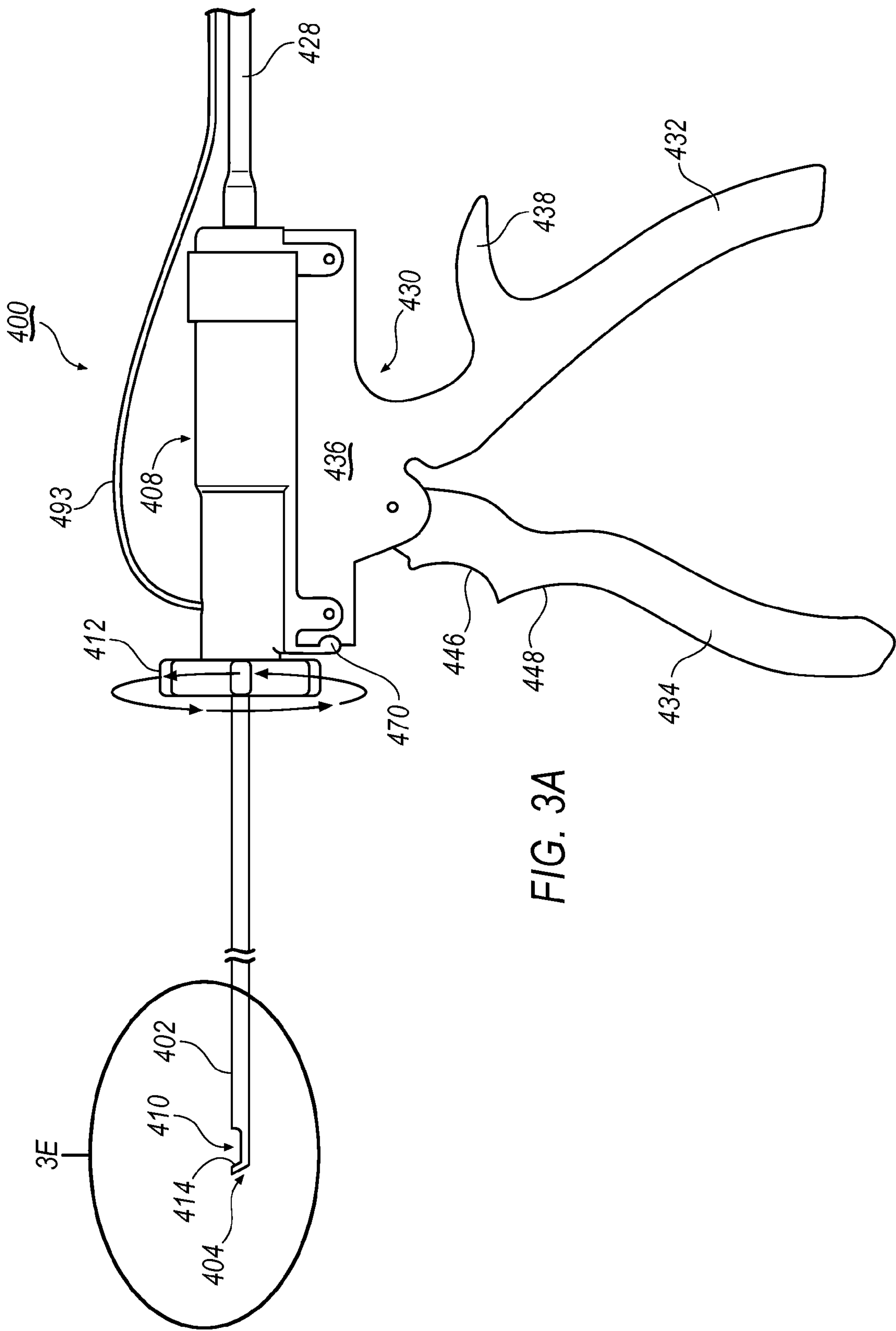
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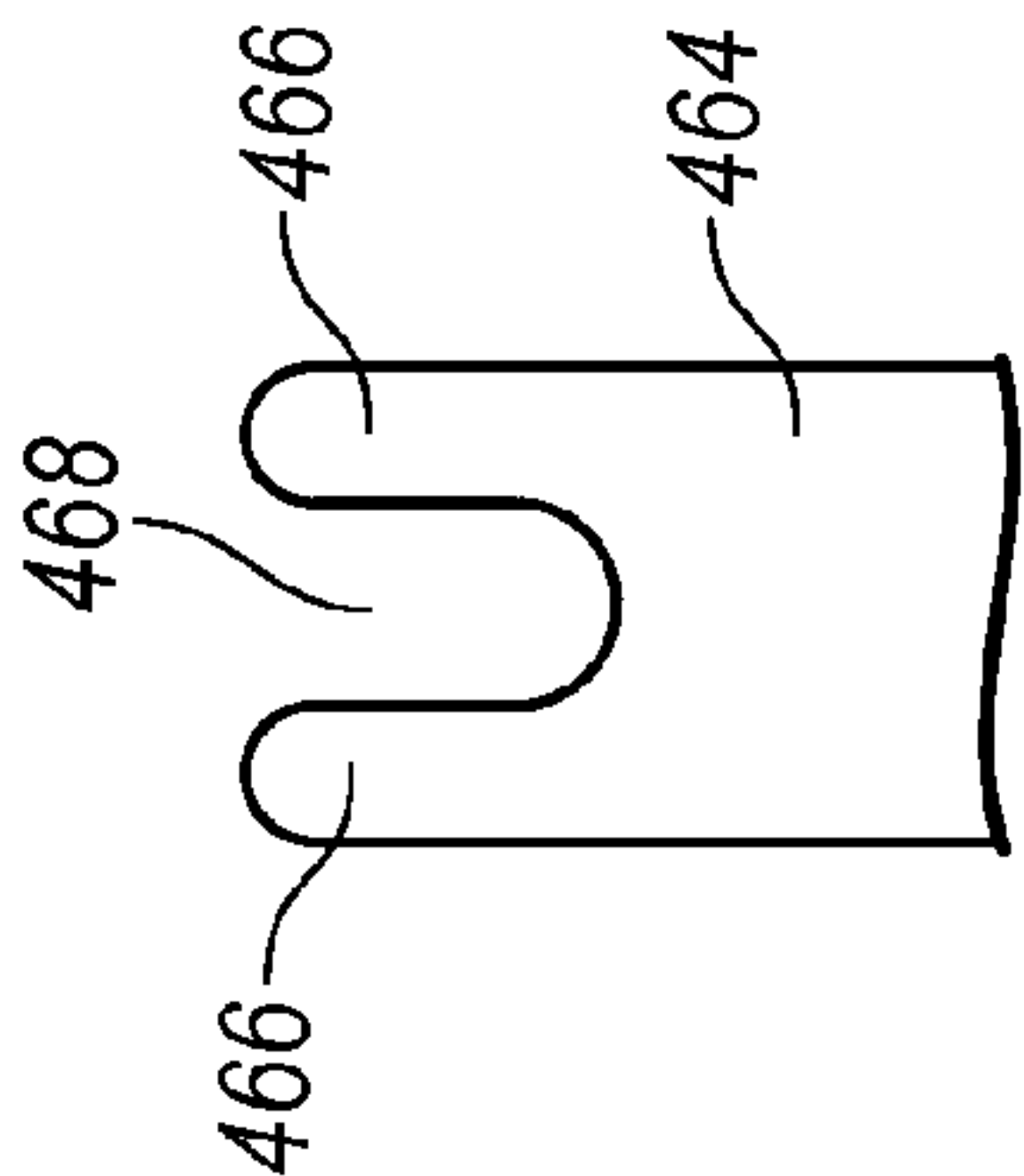
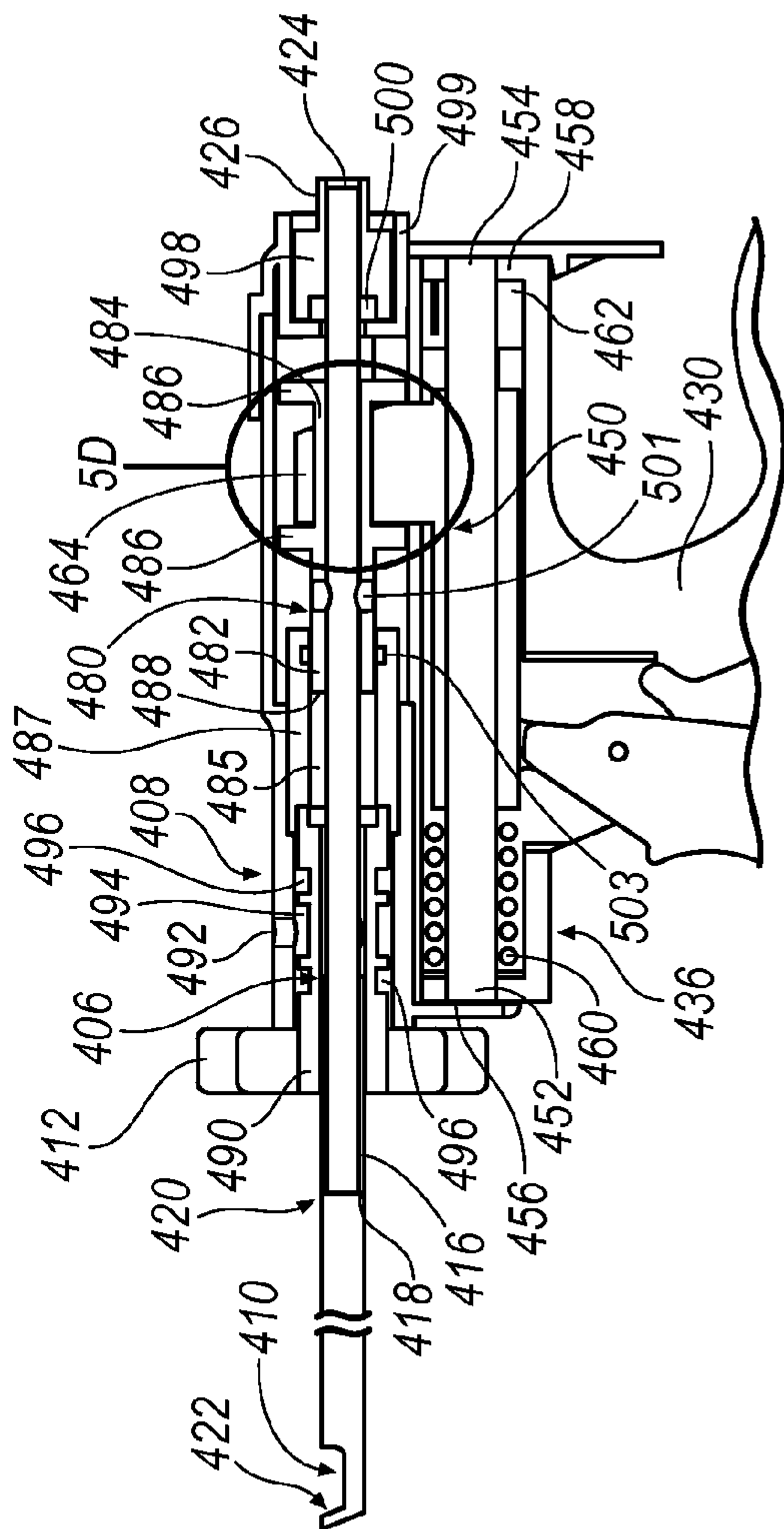
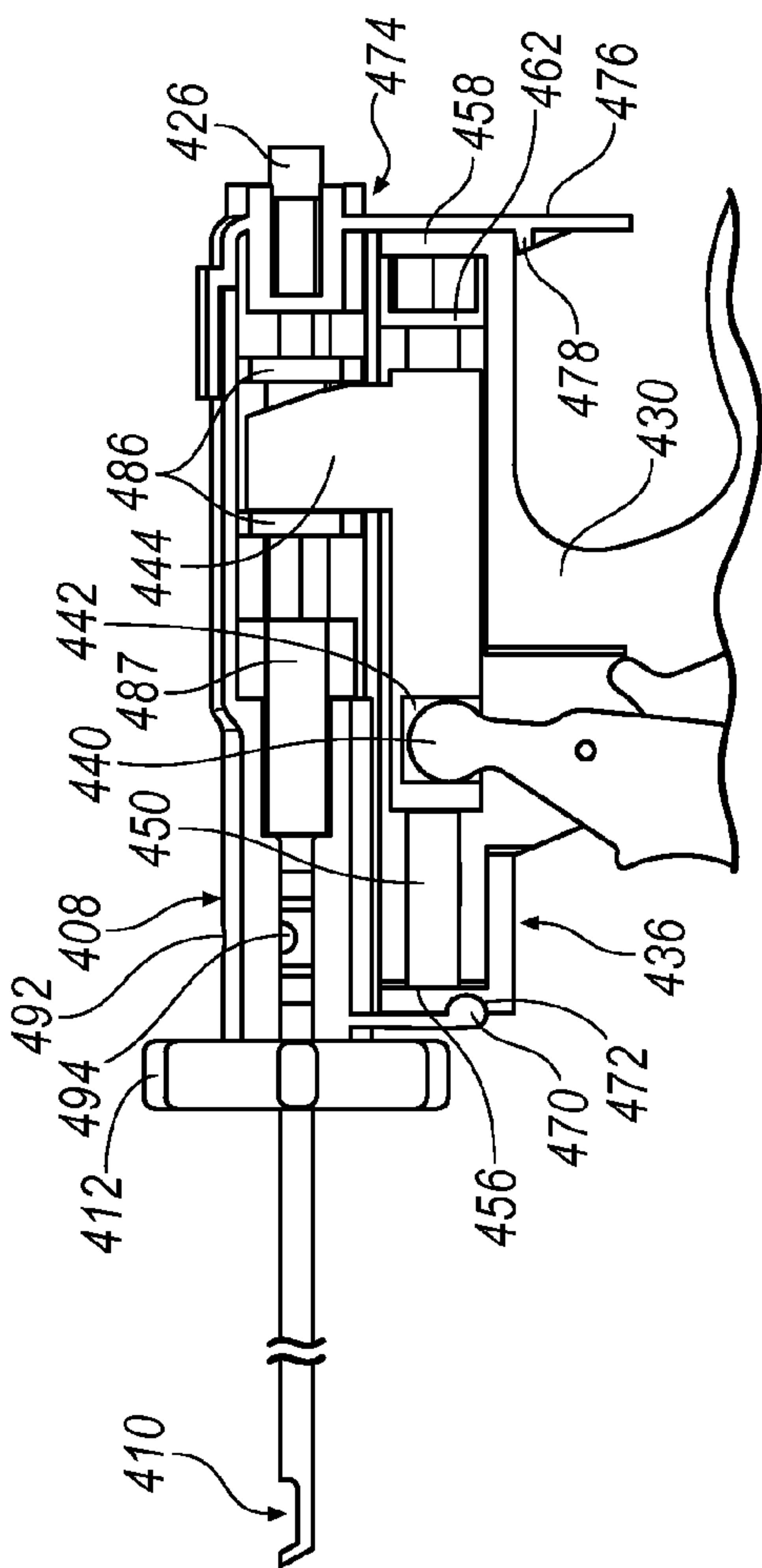
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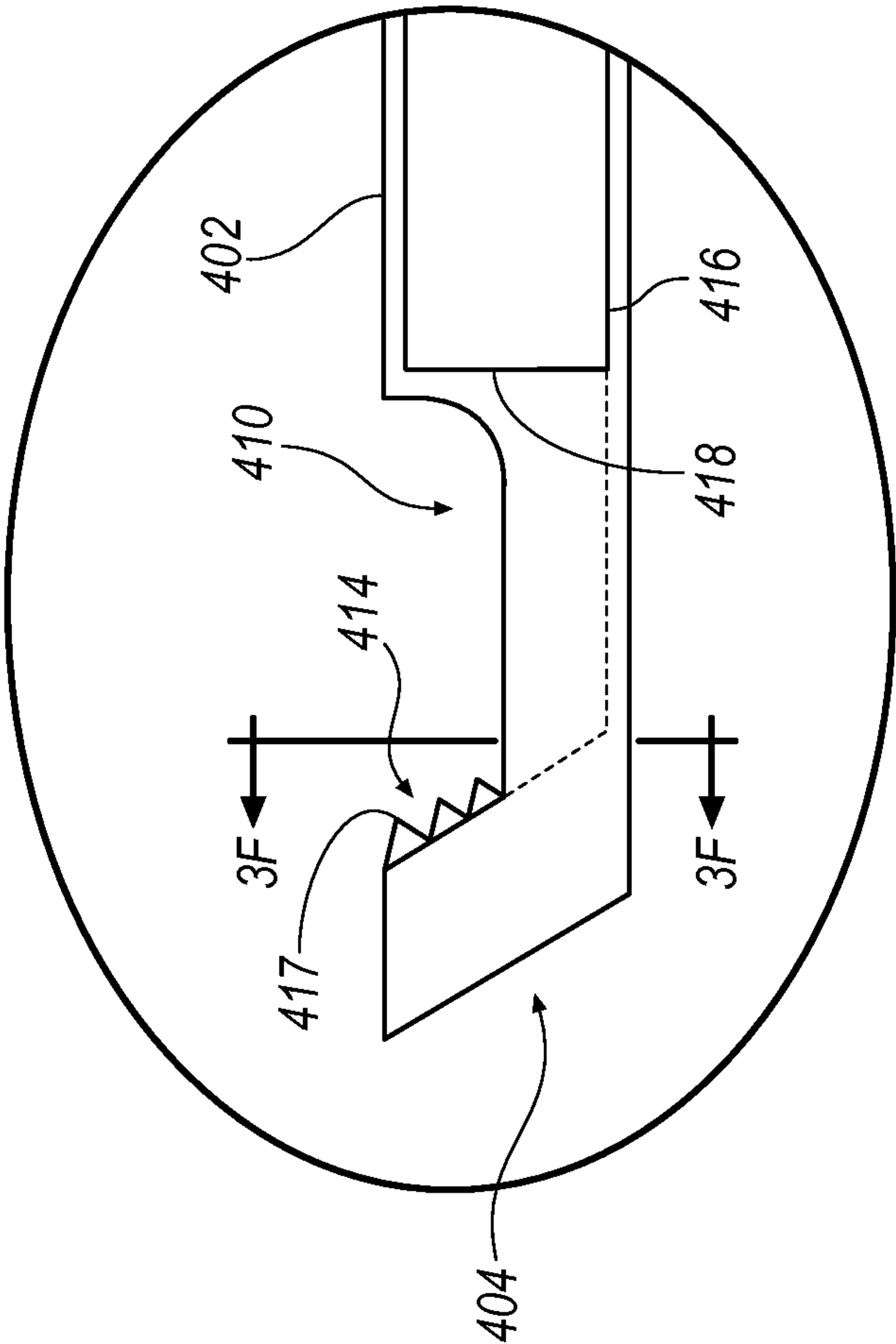


FIG. 3E

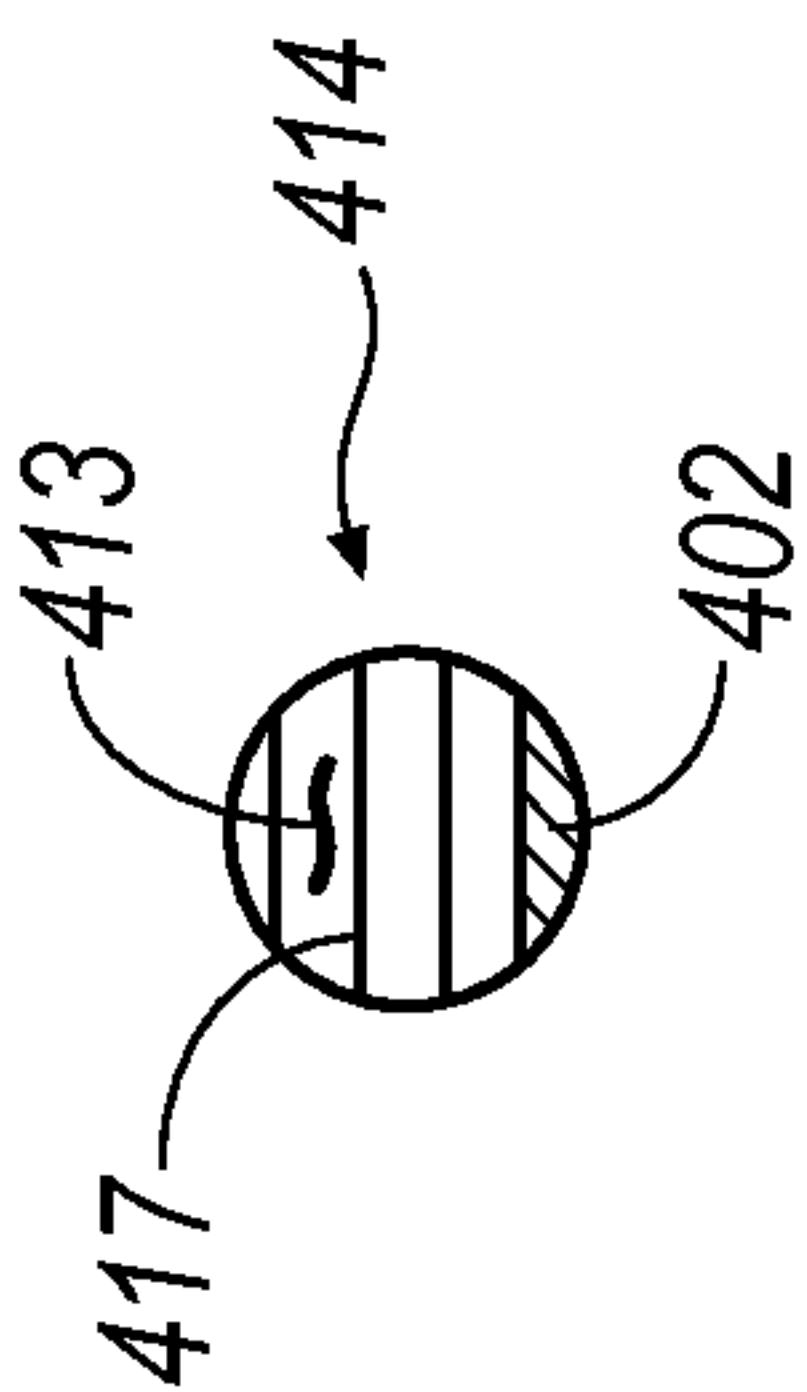


FIG. 3F

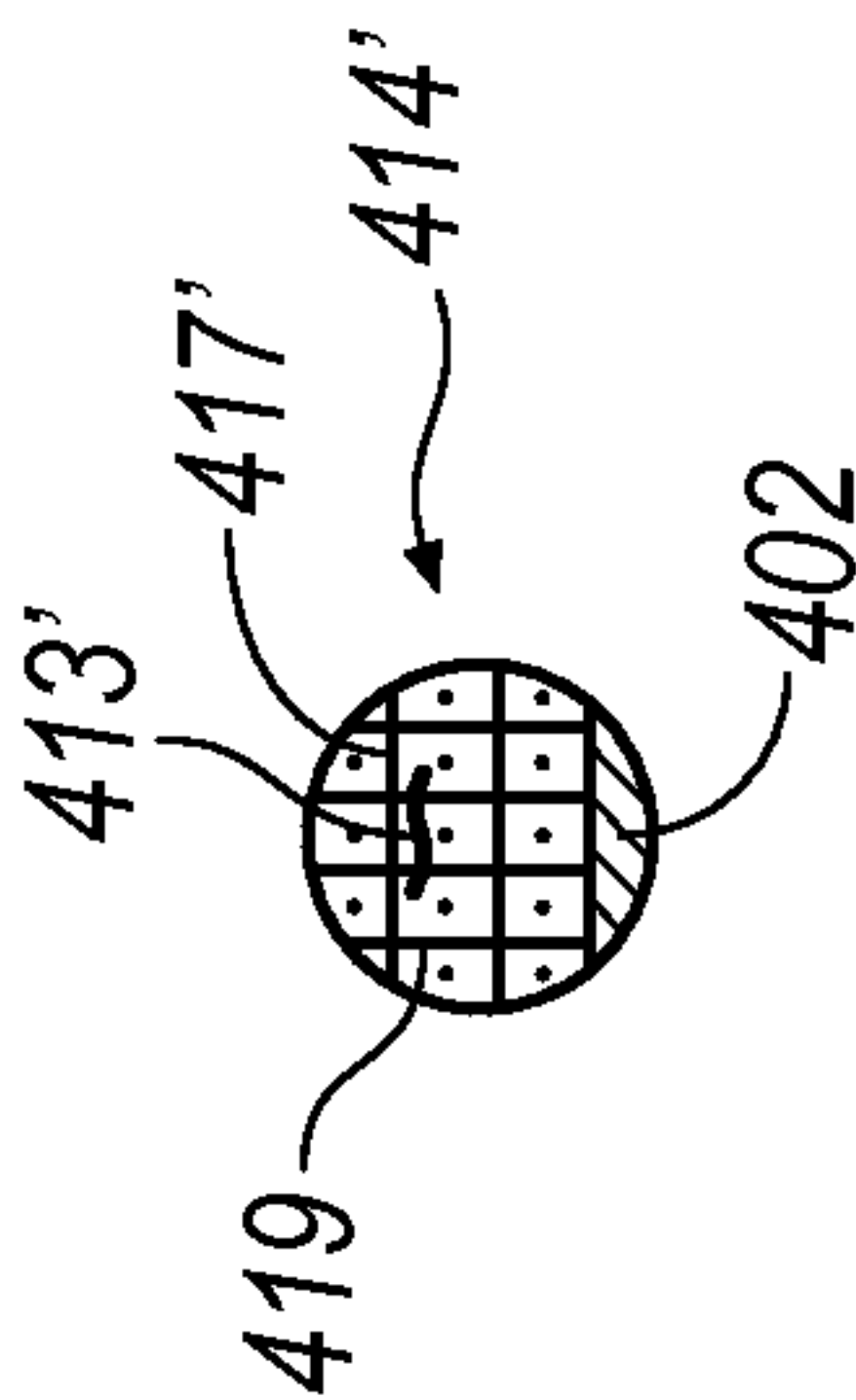
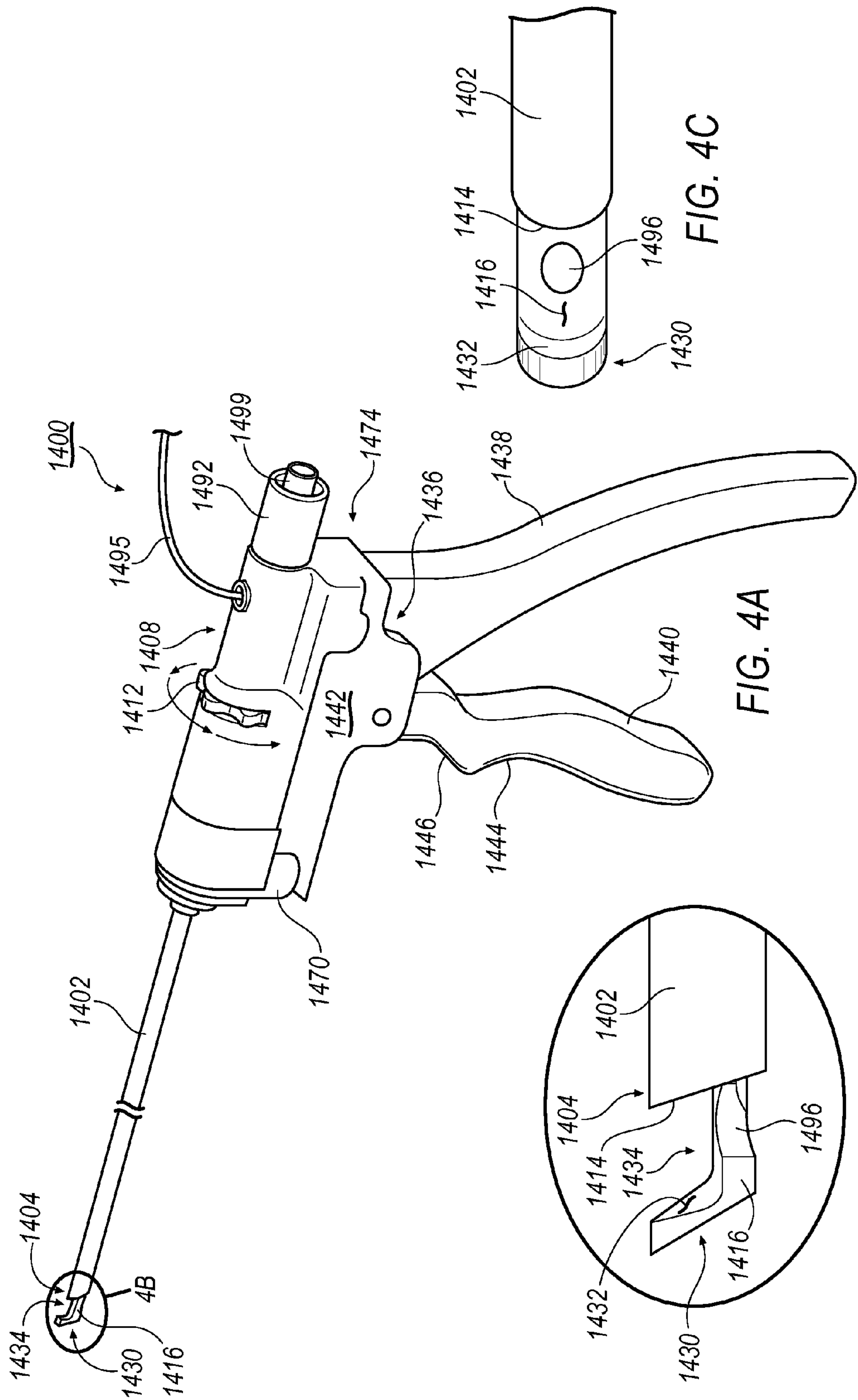


FIG. 3G



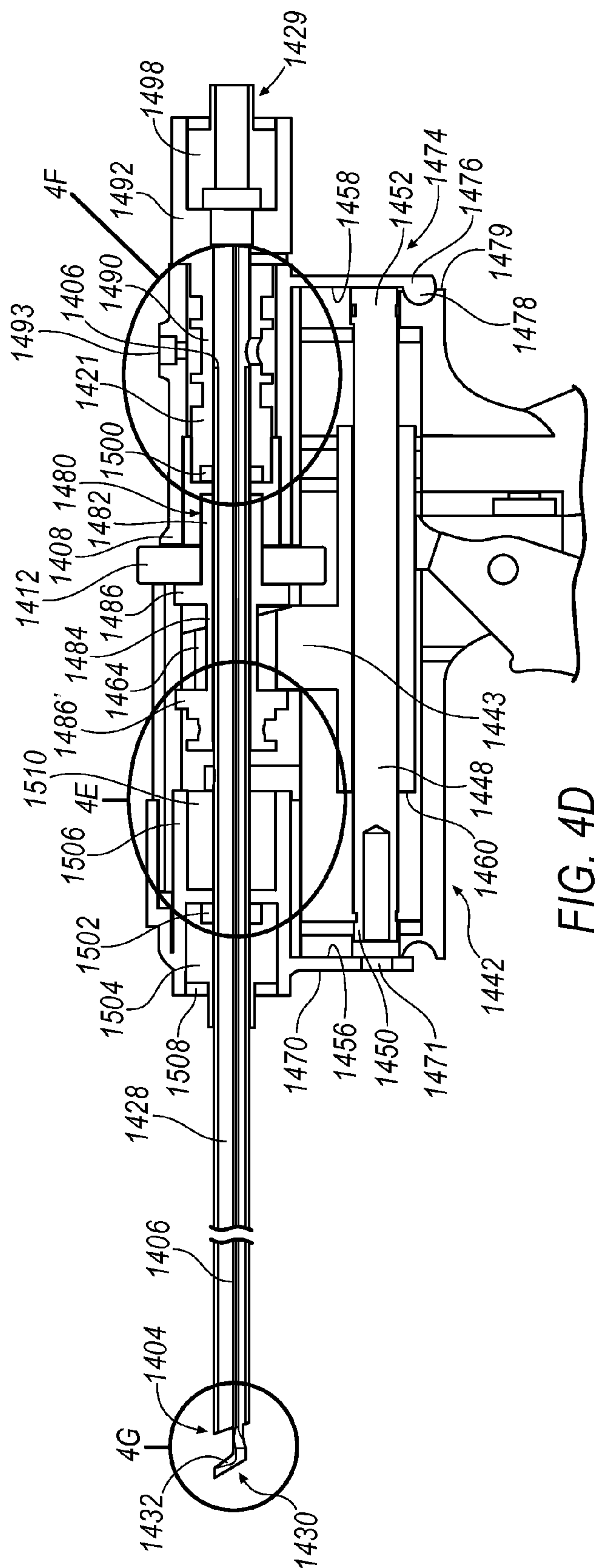


FIG. 4D

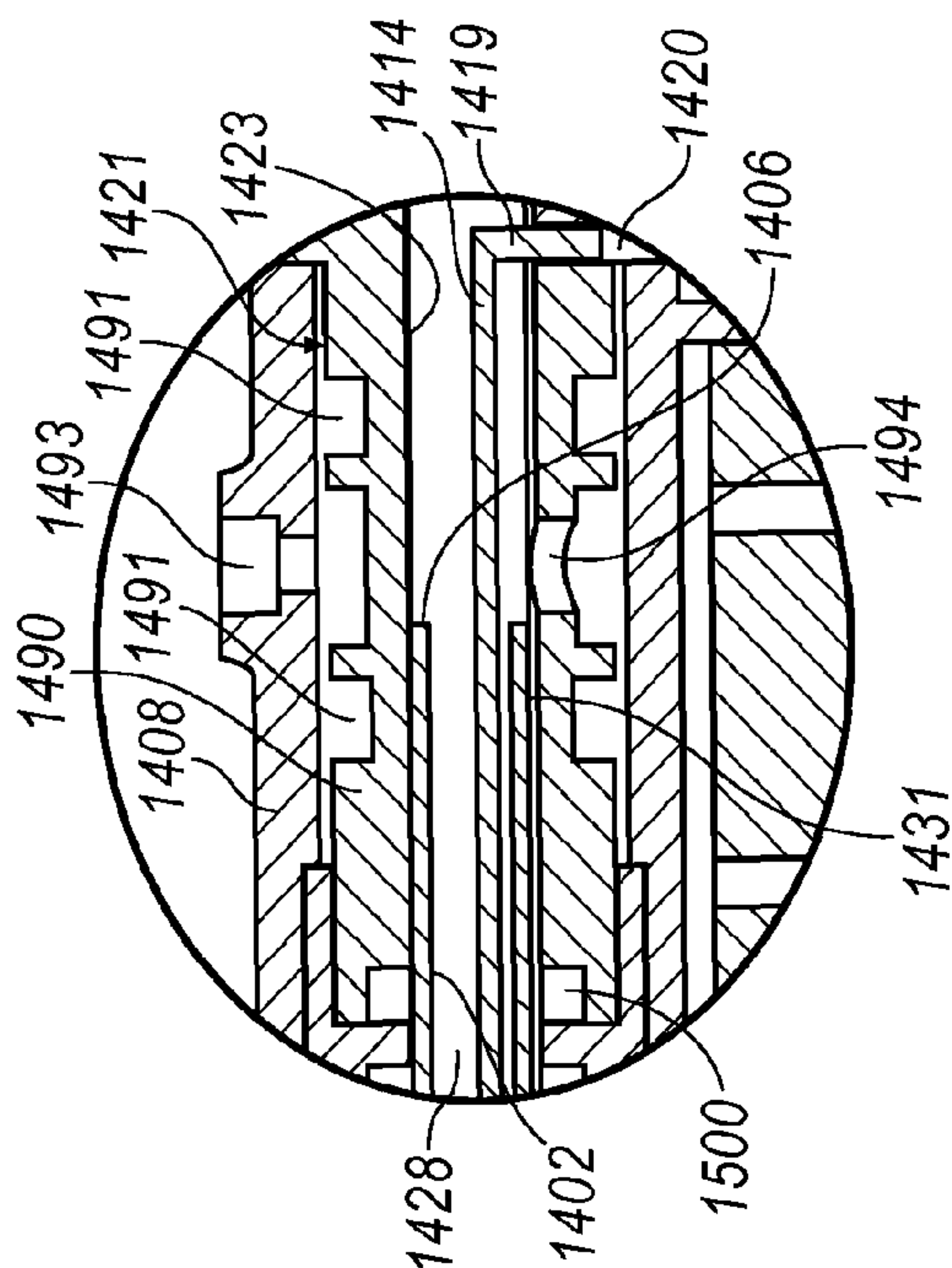


FIG. 4F

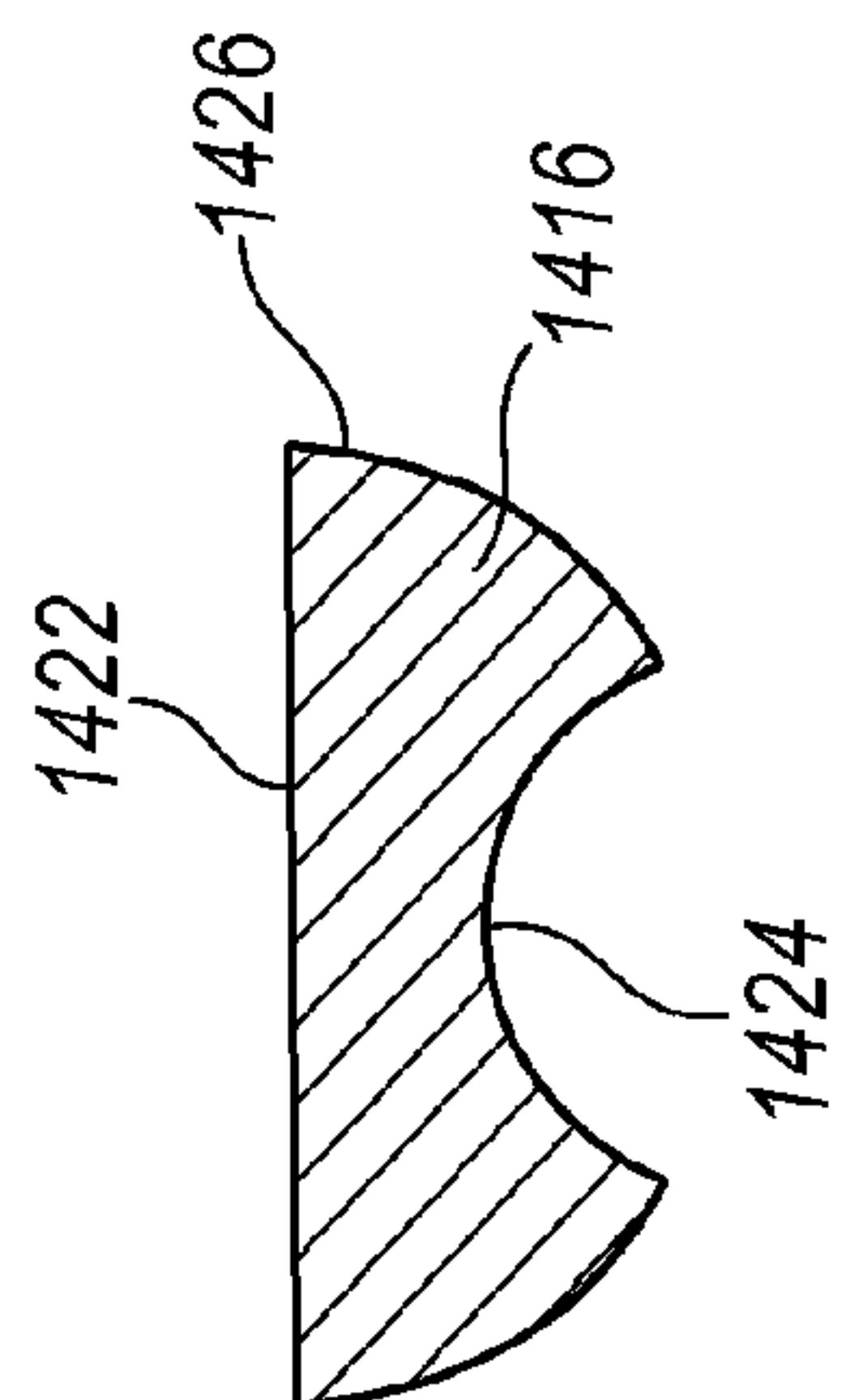


FIG. 4H

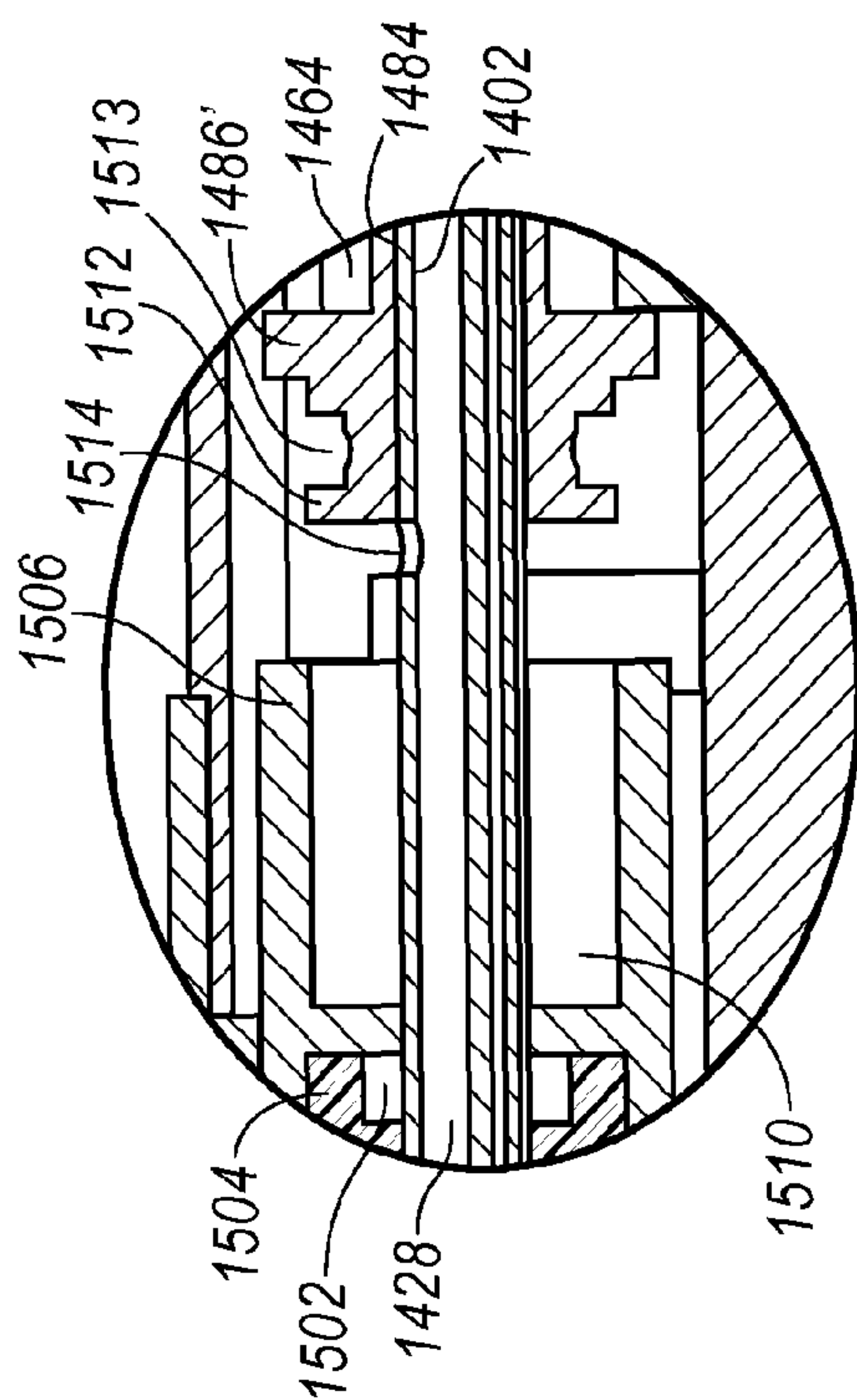


FIG. 4E

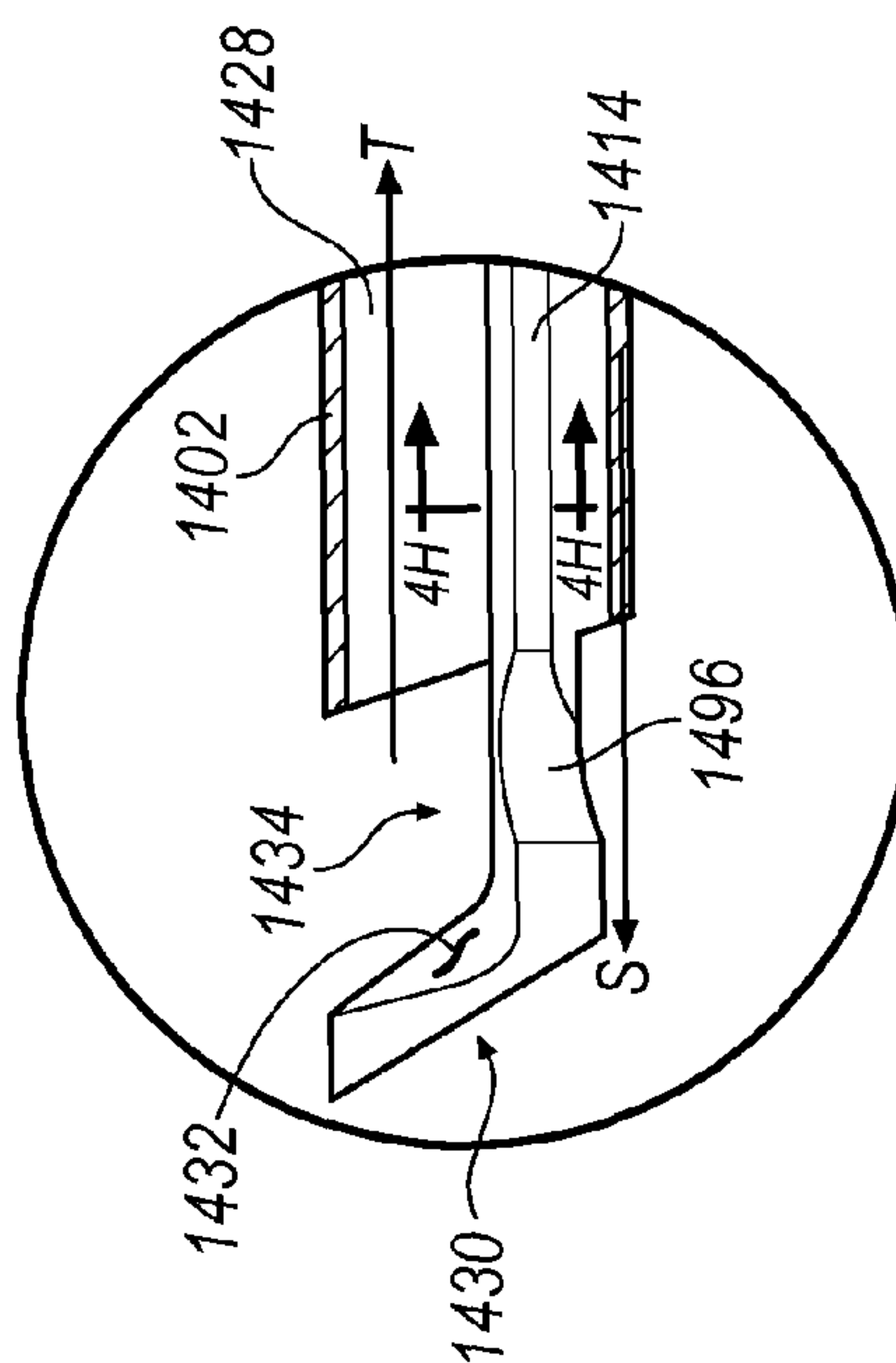


FIG. 4G

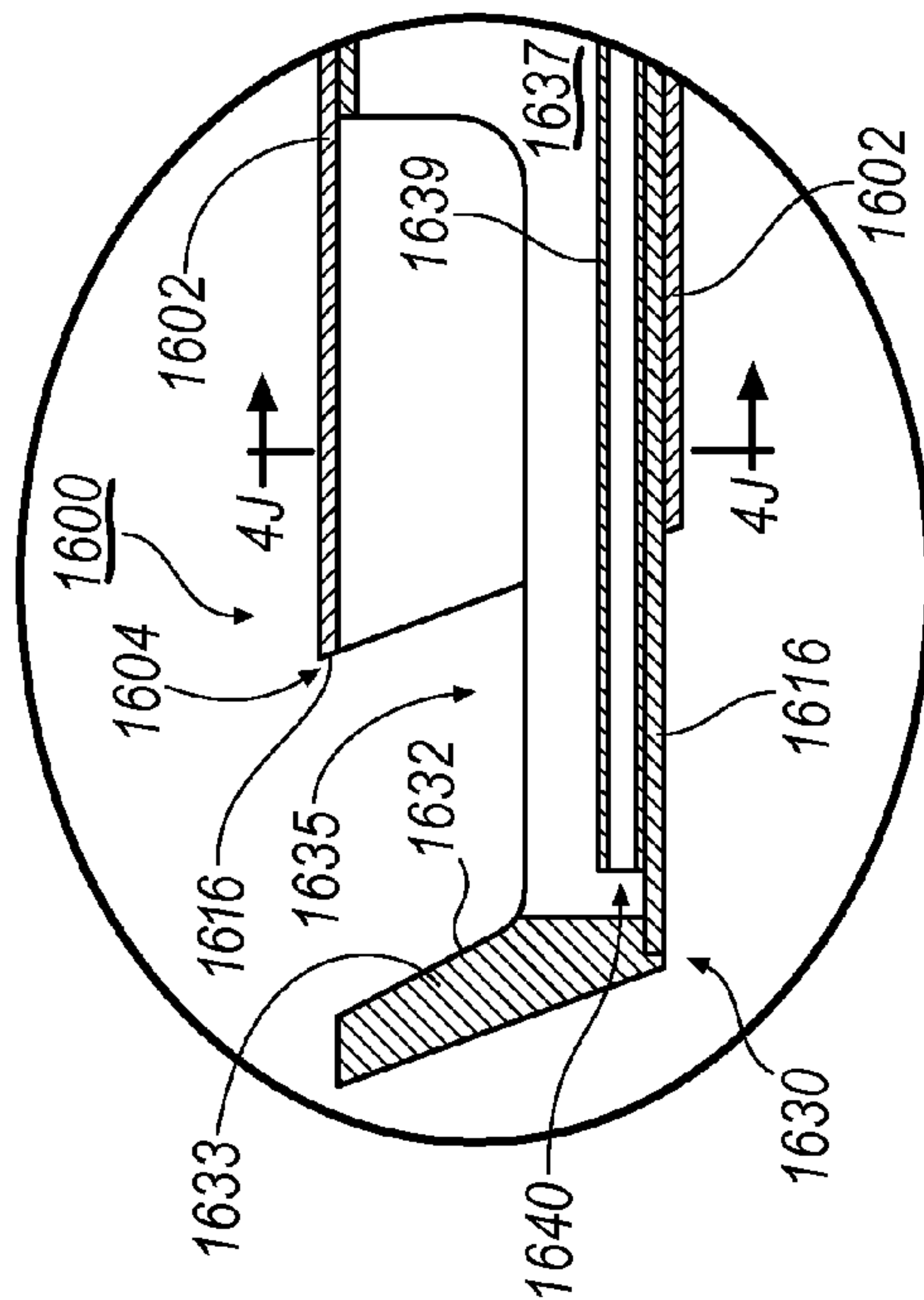


FIG. 4I

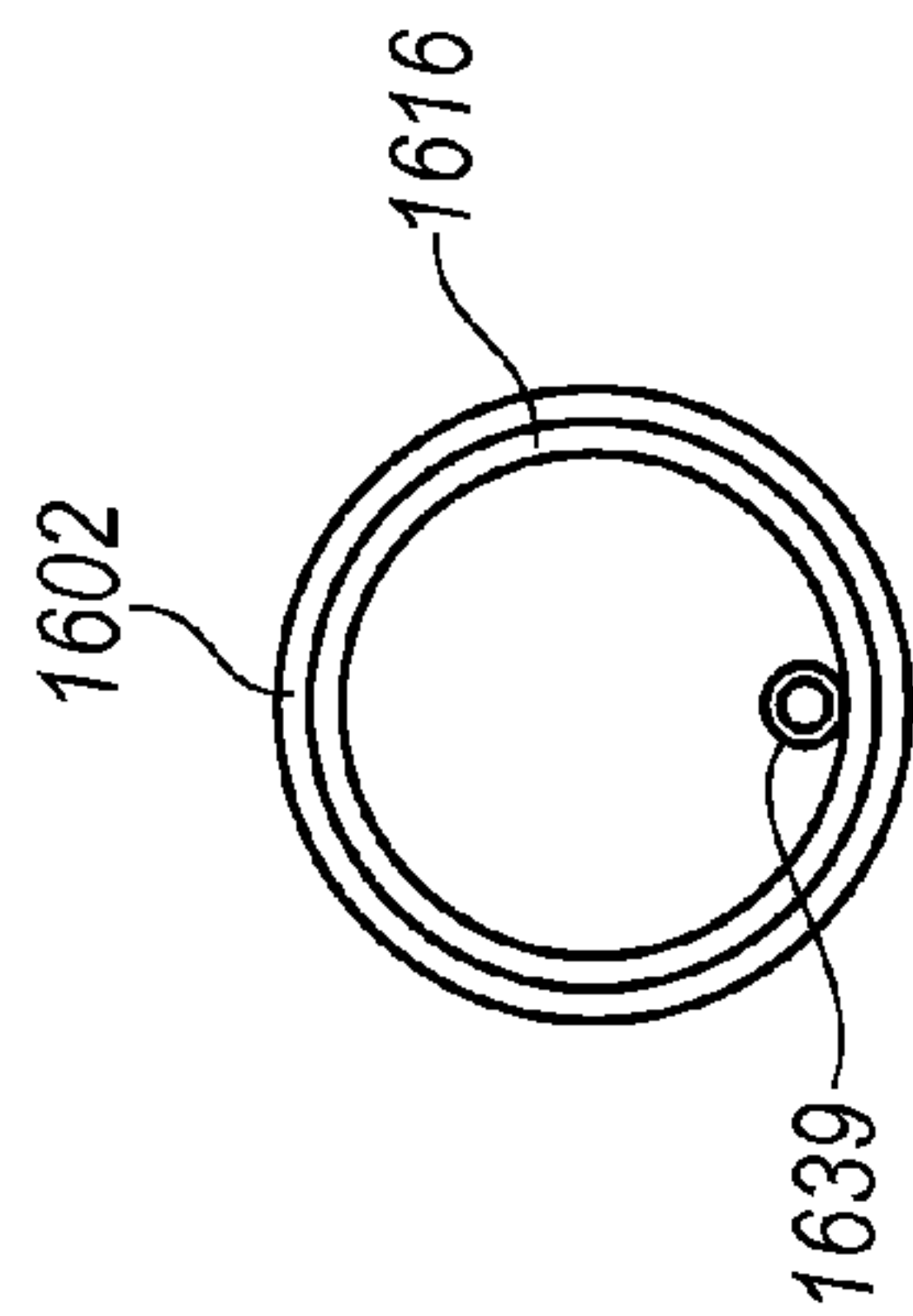


FIG. 4J

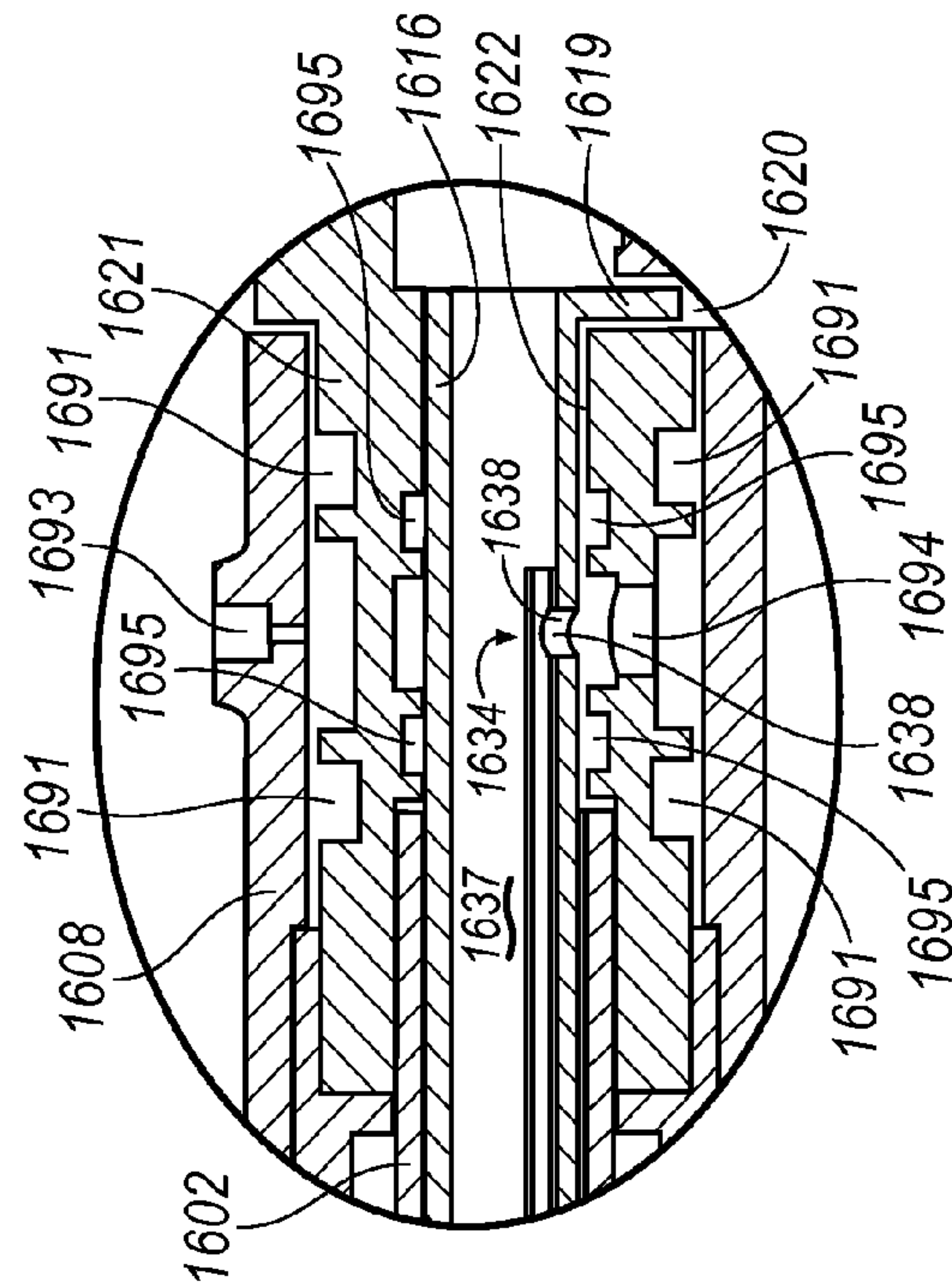


FIG. 4K

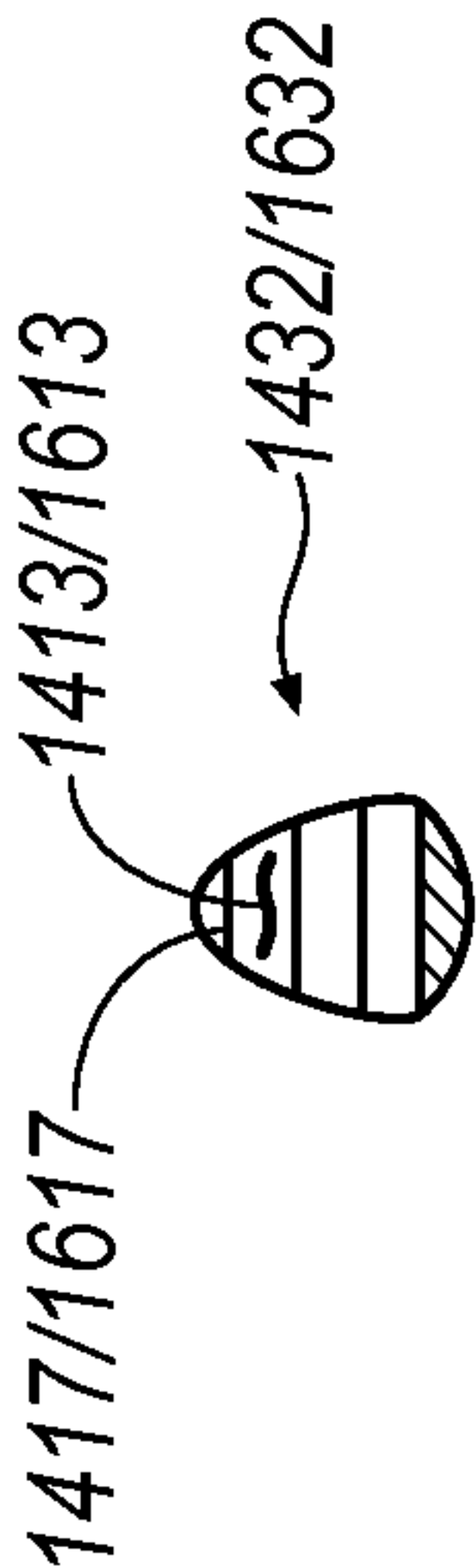


FIG. 4M

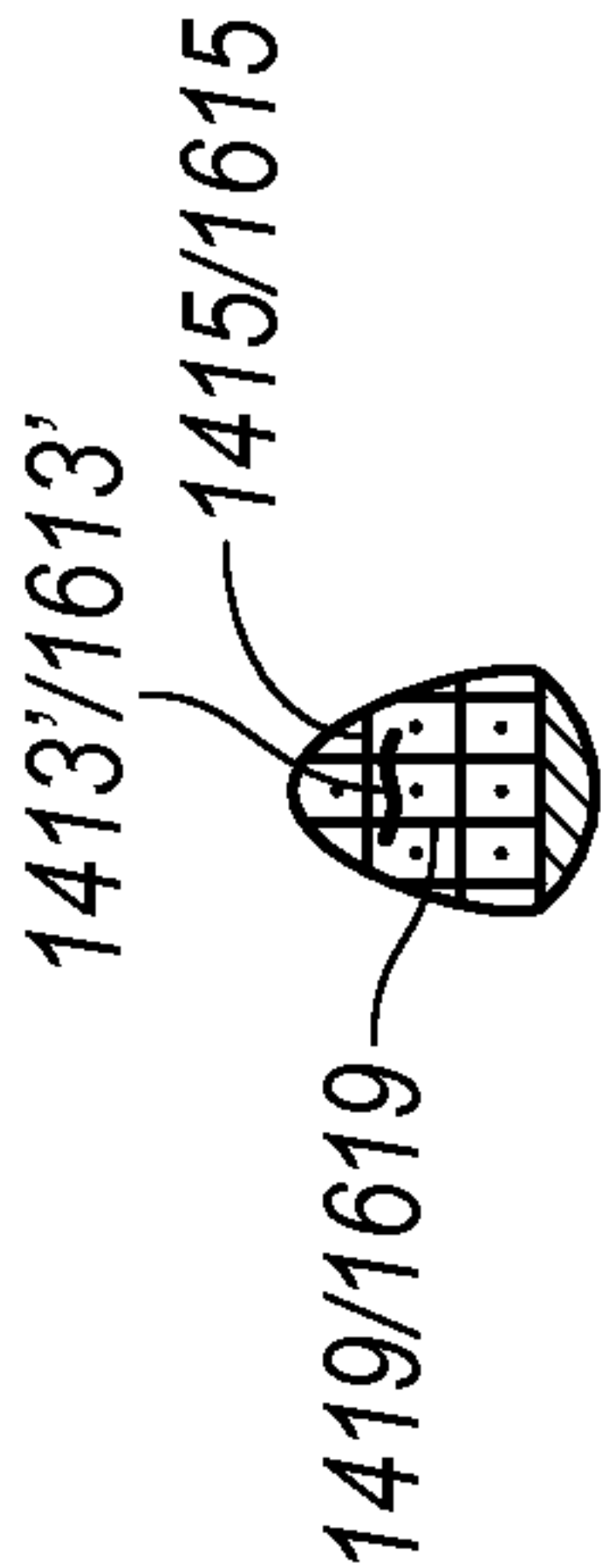


FIG. 4N

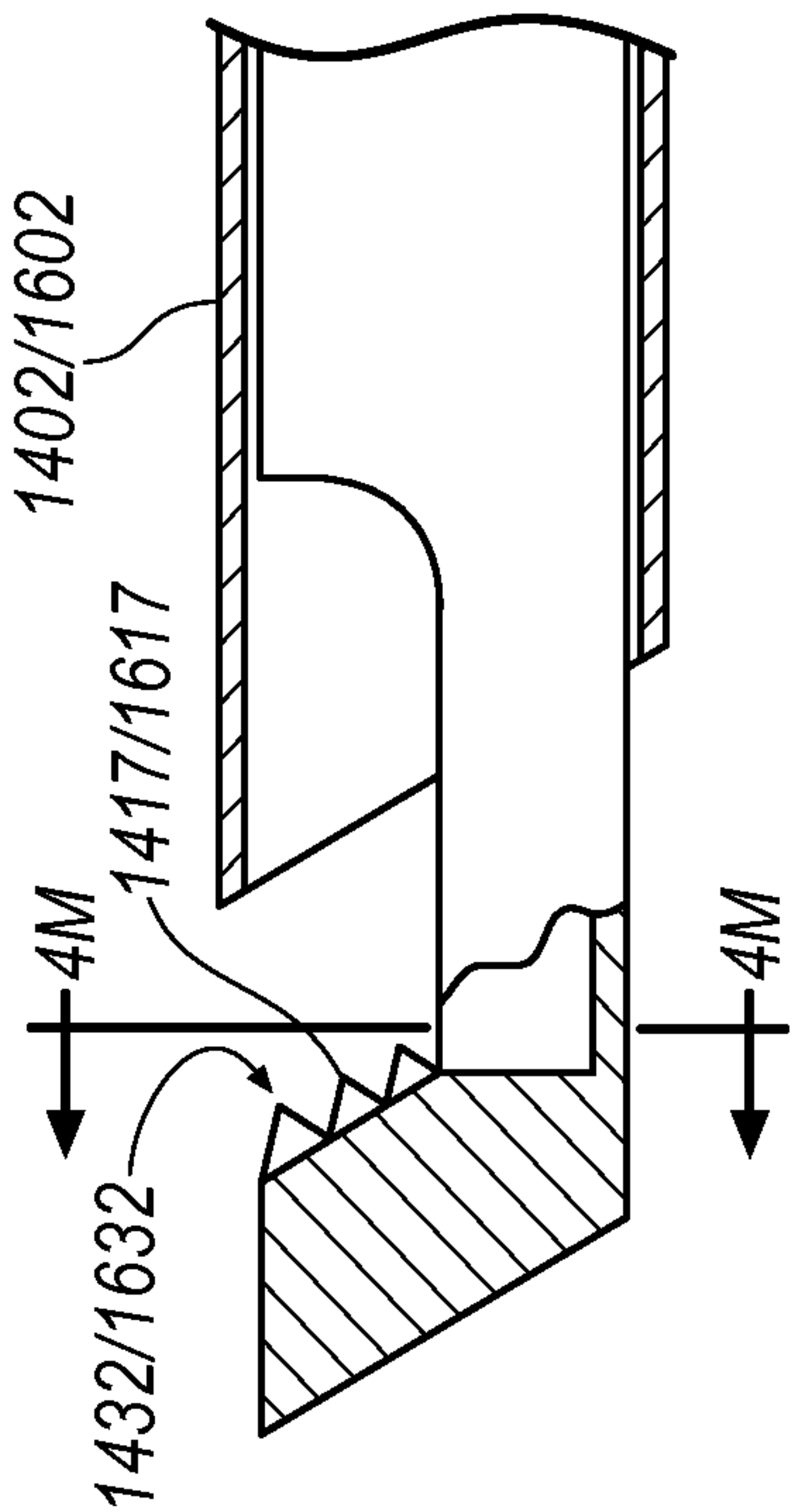


FIG. 4L

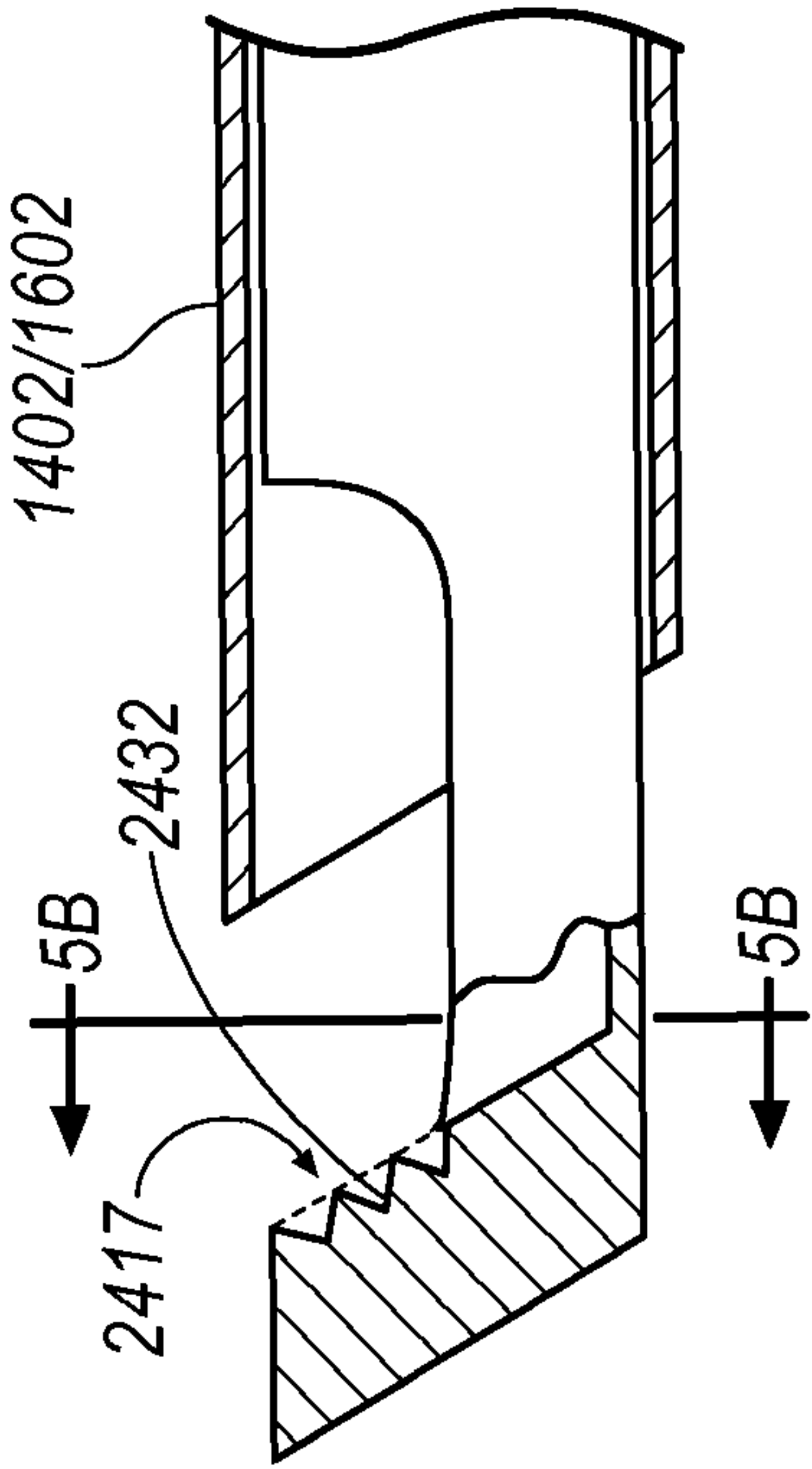


FIG. 5A

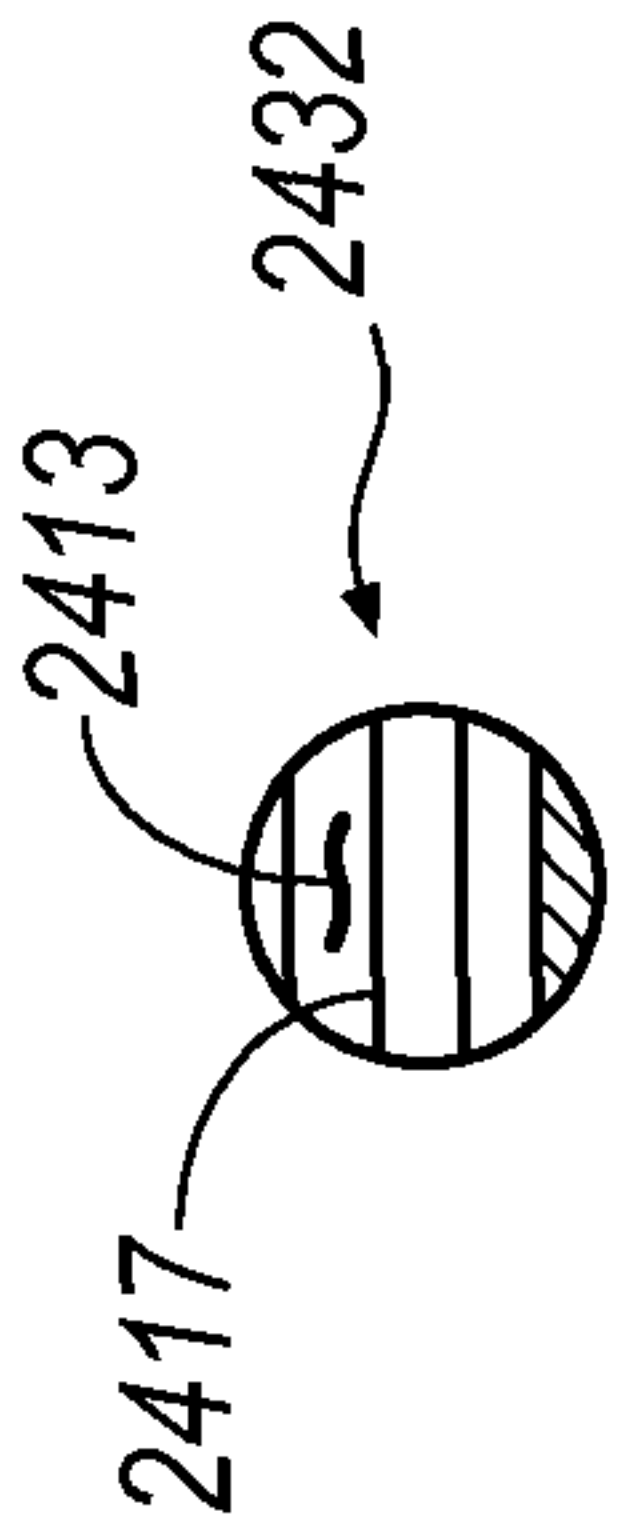


FIG. 5B

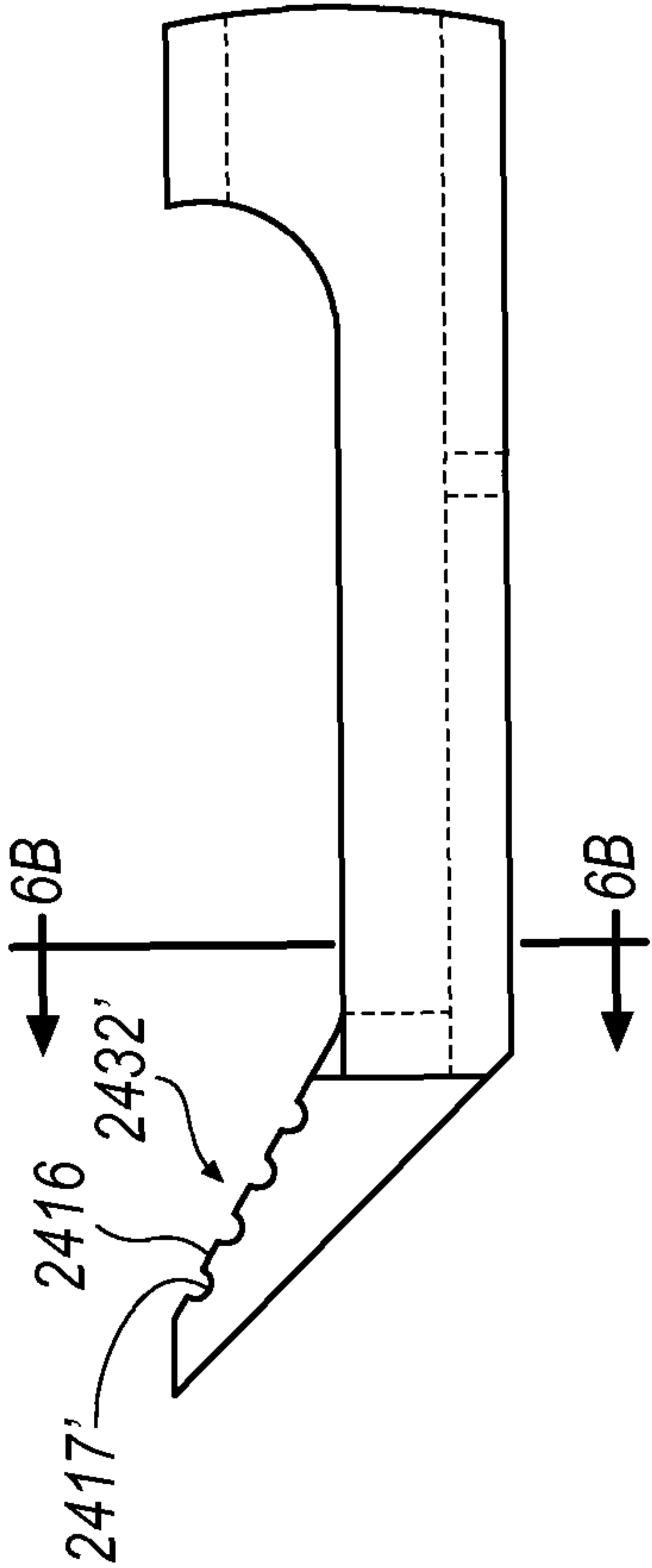


FIG. 6A

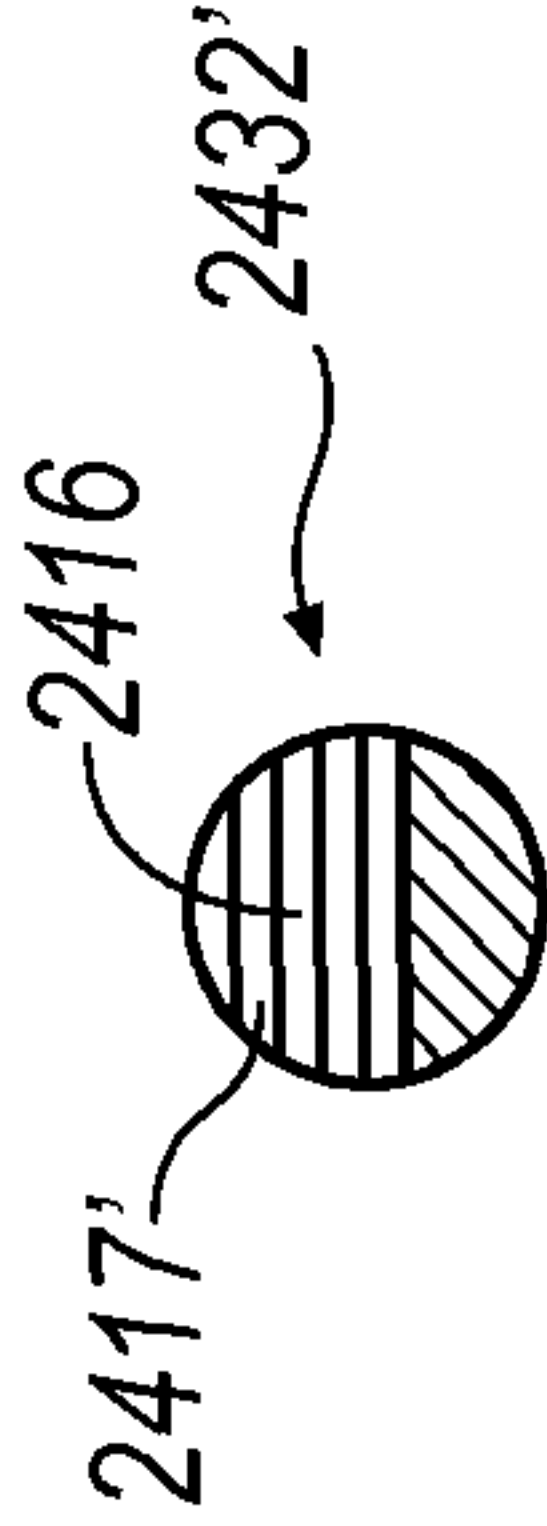


FIG. 6B

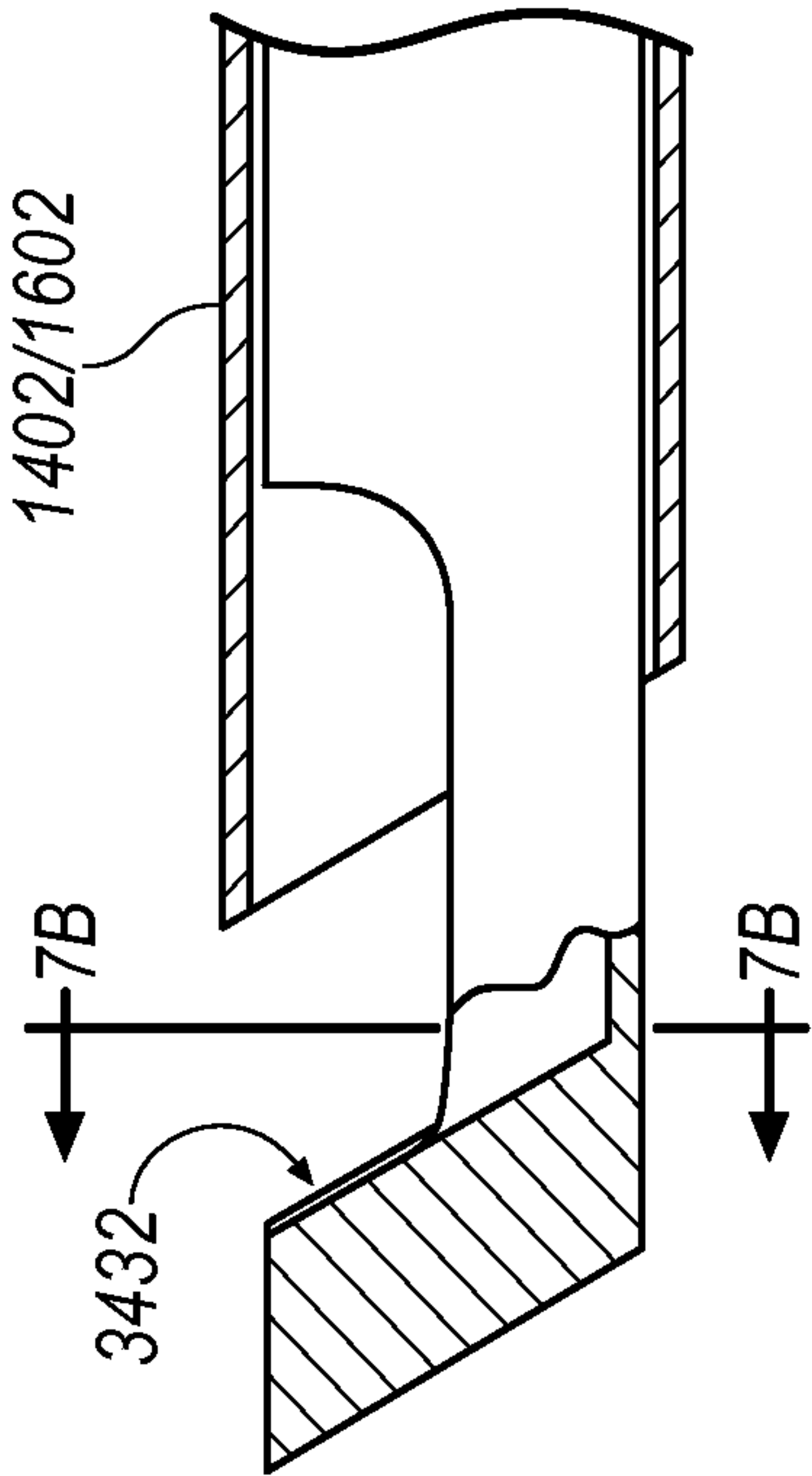


FIG. 7A

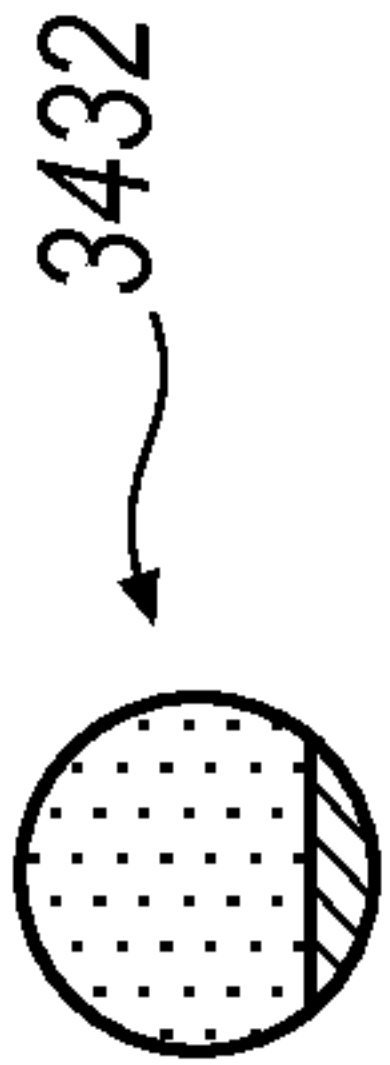


FIG. 7B

TISSUE REMOVAL DEVICE WITH TISSUE GRIP

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-in-part of U.S. patent application Ser. No. 12/700,456 filed on Feb. 4, 2010, which is now U.S. Pat. No. 8,486,097, the contents of which are incorporated by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to a tissue removal device.

BACKGROUND

Punch type forceps, referred to as rongeurs or kerrison type cutters, have been employed in a variety of medical procedures that call for excising tissue and even bony material. Such medical procedures include, for example, endoscopic procedures. Typical known forceps include a sharp cutter, or punch, that is positioned at a distal end of a hollow tube. The proximal end of the hollow tube is connected to hand grips that are squeezed together to move the punch against a footplate. In operation, when the hand grip is not actuated, a gap is formed between the footplate and the cutter. Tissue and/or bony material enters the gap and the hand grips are actuated to move the cutter against the footplate, thereby severing tissue and/or bone material that is positioned in the gap.

The foot plate in most prior art designs are configured such that the foot plate includes either a 40° angle or a 90° angle. These designs were created to address a variety of clinical needs and challenges associated with accessing tissue to enable effective cutting of tissue. For example, the 40° angle foot plate is most prominently used because it affords the ability to get under a tissue surface. More specifically, the foot plate is used as a shovel. However, gristle tissue, harder bone, and even softer tissue may slip out of the gap between the foot plate and the cutter, and off the foot plate, as the cutter is advanced towards the foot plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present disclosure will now be described in greater detail with reference to the attached figures, in which:

FIG. 1A is a side elevational view of an irrigating suction device.

FIG. 1B is a cross-sectional view of the irrigating suction device of FIG. 1A taken along lines 3B-3B.

FIG. 2A is a cross-sectional view of an alternative embodiment of an irrigating suction device.

FIG. 2B is a cross-sectional view of the irrigating suction device of FIG. 2A taken along lines 2B-2B.

FIG. 3A is a side view of an alternative embodiment of an irrigating suction device.

FIG. 3B is a partial cross-sectional view of an actuating portion of the irrigating suction device of FIG. 3A.

FIG. 3C is another partial cross-sectional view of the actuating portion of the irrigating suction device of FIG. 3A.

FIG. 3D is an end view of area 3D from FIG. 3C.

FIG. 3E is an enlarged view of area 3E taken from FIG. 3A.

FIG. 3F is an end view of a foot plate taken along lines 3F-3F in FIG. 3E.

FIG. 3G is an alternative embodiment of the foot plate taken along lines 3F-3F in

FIG. 3E.

FIG. 4A is a perspective view of an alternative embodiment of an irrigating suction device.

FIG. 4B is an enlarged side view of area 4B from FIG. 4A.

FIG. 4C is top view of a distal end of the irrigating suction device of FIG. 4A.

FIG. 4D is a cross-sectional view of the irrigating suction device of FIG. 4A.

FIG. 4E is an enlarged cross-sectional view of area 4E from FIG. 4D.

FIG. 4F is an enlarged cross-sectional view of area 4F from FIG. 4D.

FIG. 4G is an enlarged cross-sectional view of area 4G from FIG. 4D.

FIG. 4H is a cross-sectional view of an inner blade taken along lines 4H-4H in FIG. 4G.

FIG. 4I is a partial cross-sectional view of a distal end of an alternative arrangement of an irrigation suction punch.

FIG. 4J is a cross-sectional view of the distal end taken along lines 4J-4J of FIG. 4I.

FIG. 4K is a partial cross-sectional view of an alternative arrangement of a saline hub.

FIG. 4L is a partial cross-sectional view of an alternative configuration for a distal end of the irrigation suction punch such as that illustrated in either FIGS. 4A-4H or FIGS. 4I-4K.

FIG. 4M is an end view of a foot plate taken along lines 4M-4M in FIG. 4L.

FIG. 4N is an alternative embodiment of the foot plate taken along lines 4N-4N in FIG. 4L.

FIG. 5A is partial cross-sectional view of an alternative configuration for a distal end of the irrigation suction punch such as that illustrated in either FIGS. 4A-4H or FIGS. 4I-4K.

FIG. 5B is an end view of the foot plate taken along lines 5B-5B in FIG. 5A.

FIG. 6A is a partial cross-sectional view of an alternative configuration for a distal end of the irrigation suction punch, as that illustrated in either FIGS. 4A-4H or FIGS. 4I-4K.

FIG. 6B is an end view of the foot plate taken along lines 6B-6B in FIG. 6A.

FIG. 7A is a partial cross sectional view of an alternative configuration for a distal end of the irrigation suction punch such as that illustrated in either FIGS. 4A-4H or FIGS. 4I-4K.

FIG. 7B is an end view of the foot plate taken along lines 7B-7B in FIG. 7A.

DETAILED DESCRIPTION

Referring now to the discussion that follows and also to the drawings, illustrative approaches to the disclosed systems and methods are shown in detail. Although the drawings represent some possible approaches, the drawings are not necessarily to scale and certain features may be exaggerated, removed, or partially sectioned to better illustrate and explain the present disclosure. Further, the descriptions set forth herein are not intended to be exhaustive or otherwise limit or restrict the claims to the precise forms and configurations shown in the drawings and disclosed in the following detailed description.

Described herein is a method of tissue resection, as well as various components of a device used in same. The components disclosed herein provide surgeons with an enhanced ability to minimize trauma to the patient, while providing effective and efficient minimally invasive surgical techniques.

Referring to FIGS. 1A-1B, a first embodiment of a suction punch 200 is provided. A first embodiment of a suction punch 200 includes a base member 202 and a selectively slidable

cutting member **204** that slides on base member **202**. A distal end **206** of suction punch **200** extends upwardly from base member **202** and forms a cutting surface **208**.

Suction punch **200** further comprises an actuator assembly **210**. Actuator assembly **210** comprises a first gripping member **212** and a second gripping member **214**. First gripping member **212** includes a first end **216** that is pivotally connected to a sleeve **218**. A second end **220** of the first gripping member **212** may be configured as a gripping member with an opening **222** for receiving a finger or thumb. Second gripping member **214** includes a first end **224** that is fixedly connected to base member **202**. A second end **226** of the second gripping member **214** may also be configured as a gripping member with an opening **228**.

Slidable cutting member **204** is defined by an open distal end **230** and an open proximal end **232**. Slidable cutting member **204** is moveable between an open position and a cutting position. In the open position, distal end **230** is spaced away from cutting surface **208** to create a tissue receiving opening **233**, as seen in FIG. 1A. In the cutting position, distal end **230** is slid into contact with cutting surface **208**, thereby effectively closing tissue receiving opening **233** and cutting tissue that prolapses within tissue receiving opening **233** (to be explained below).

Distal end **230** is configured with a cutting edge sufficiently sharp to sever tissue, as will be explained in further detail below. Proximal end **232** is configured to receive a fitting (not shown) that is attached to a tubing line (not shown) that is operatively connected to a vacuum source. Accordingly, vacuum is delivered through cutting member **204** (indicated by arrow V) during operation of suction punch **200**. Sleeve **218** is fixedly connected to cutting member **204** adjacent proximal end **232**.

In operation, distal end **206** of suction punch **200** is inserted into the patient positioned adjacent tissue of interest. To insure proper placement of suction punch **200**, suction punch **200** may be placed in the closed position prior to insertion (so as not to drag or snag tissue on cutting surface **208**). While being inserted, the vacuum source is on, but may be vented to atmosphere to also prevent tissue from being pulled into suction punch **200** until properly positioned. To permit venting, an aperture **233** (shown in phantom) may be formed through a sidewall of cutting member **204**. When suction punch **200** is in the open position, the aperture is unblocked, to permit venting of the device. When suction punch **200** is in the closed position, aperture **233** is sealed off, thereby retaining vacuum. In one exemplary embodiment, a sealing sleeve **235** may be provided, whereby the sealing sleeve **235** (shown in phantom) is fixedly connected to base **202** and cutting member **204** is configured to slide therethrough. As cutting member **204** moves distally, aperture **233** slides into sealing sleeve **235**, which may include a pair of seals, such as O-rings, at either end thereof. Once received therein, aperture **235** is effectively sealed and vacuum is restored to suction drive **200**. Other configurations to provide selective venting is also contemplated. Once positioned, the vacuum is restored (by closing off the vent) and the suction punch **200** is placed in the open position. The vacuum source mechanically draws tissue into the tissue receiving opening **233**. Next, the first gripping member **212** is actuated towards the second gripping member **214**, as indicated by arrow F. This action causes cutting member **204** to slide along the base member **202** such that distal end **230** of cutting member **204** moves toward cutting surface **208** as indicated by arrow C. In one exemplary embodiment, cutting surface **208** is provided with a cutting lip **236** that cooperates with the cutting edge formed on distal end **230** of cutting member **204** to cleanly sever tissue.

Because suction device **200** is configured to deliver vacuum to tissue receiving opening **233**, each manual cutting action automatically delivers the severed portions of the tissue (such as turbinates **12** for an endonasal approach) away from the patient. In one embodiment, a tissue filter (not shown) may be provided for retaining the severed portions of tissue. The tissue filter may be directly attached to the proximal end **232** of suction device **200**. Alternatively, the tissue filter may be positioned remotely and operatively connected to the suction device **200** by tubing.

Unlike prior art punch devices, such as the Kerrison punch, only a single insertion of suction device **200** is required to sever any tissue in the desired pathway. Indeed, multiple tissue cutting actions can be accomplished with a single insertion. Thus, suction device **200** permits a speedier procedure, as well as less trauma to the patient.

To prevent tissue from occluding suction device **200**, base member **202** may further be provided with an irrigation channel **238**. Irrigation channel **238** extends from an open proximal end **240** of base member **240**. Proximal end **240** may be configured to receive a fitting that is connected to an irrigation supply by tubing (not shown). A suitable irrigation supply may include saline or ringers.

Irrigation channel **238** further comprises a distal end **242** that adjoins an elongated mating channel **244** (best seen in phantom in FIG. 1B) formed adjacent cutting surface **208** in distal end **206** of suction device **200**. Mating channel **244** is in communication with an opening **246** that extends through cutting surface **208**.

In operation, irrigation is provided through irrigation channel **238** and delivered to tissue receiving opening **233**. As the tissue is being severed, irrigation is being delivered to the tissue removed from the patient's body, lubricating the tissue and serving as a flushing mechanism to deliver tissue through suction punch **200** and prevent occlusion. Further, as discussed above, vacuum may also be applied to flush the irrigation fluid out of patient as suction device **200** operates.

Components of an alternative arrangement of a base member **302** of a suction punch **300** is shown in FIGS. 3A-3B. FIG. 3A is a cross-sectional view of base member **302**. As may be seen, base member **302** is connected to a distal end **306** of suction punch **300**, which defines a cutting surface **308**. A cutting lip **336** may also be provided on cutting surface **308**.

Like suction punch **200**, base member **302** of suction punch **300** includes an irrigation channel that extends from a proximal end **334** along the length of base member **302** to a distal end **342**. At proximal end **334**, irrigation channel **302** is operatively connected to an irrigation supply, as described above in connection with suction punch **200**. At distal end **342**, irrigation channel connects to a groove **344** that adjoins an opening **346** formed at a base **347** of cutting surface **308**. Thus, in operation, irrigation fluid may be supplied to base **347** of cutting surface **308**.

Yet another alternative embodiment of a suction punch **400** is shown in FIGS. 3A-5G. Suction punch **400** includes an outer cannula **402** defined by a distal end **404** and a proximal end **406** (seen best in FIG. 3C), which is seated within a housing member **408** (to be explained in further detail below). A tissue receiving opening **410** is formed in outer cannula **402** adjacent distal end **404**. Outer cannula **402** is configured for selective rotational movement. More specifically, a rotation dial **412** is fixedly secured to an outer surface of outer cannula **402**. In one particular embodiment, a glue interference is used to fix rotation dial **412** to outer cannula **402**. As rotation dial **412** is rotated, tissue receiving opening **410** is also rotated, thereby allowing for easy manipulation of suction punch **400**.

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during procedures. Formed at distal end **404** of outer cannula **402**, distally of tissue receiving opening **410**, is a cutting surface or foot plate **414**.

Referring to FIG. 3C, disposed within outer cannula **402** is an inner cutting cannula **416**. Inner cutting cannula **416** includes a cutting edge **418** disposed on a distal end **420** thereof. Cutting edge **418** cooperates with a distal edge **422** of tissue receiving opening **410** to sever tissue that is received within tissue receiving opening **410**. A proximal end **424** of inner cutting cannula **416** is disposed in a fitting barb **426**, to which a vacuum line **428** is operatively connected. Inner cutting cannula **416** is slidably seated within housing member **408**. In other words, inner cutting cannula **416** is configured to selectively slide or reciprocate within outer cannula **402** during operation. However, inner cutting cannula **416** is also rotationally fixed with respect to outer cannula **402** such that rotation of rotation dial **412** also serves to rotate inner cutting cannula **416** with outer cannula **402**.

Housing member **408** is mounted to an actuation member **430**. Actuation member **430** comprises a first handle device **432** and a second handle device **434**. First handle device **432** is fixedly connected to a shuttle housing **436**. In one exemplary configuration, shuttle housing **436** is integrally formed with first handle device **432**. First handle device **432** may further be configured with a thumb grip **438** for ease of use.

Second handle device **434** is pivotally connected to shuttle housing **436**. Referring to FIG. 3B, a first end **440** of second handle device **434** is received within a slot **442** that is formed within a selectively slidable shuttle member **444** that is disposed within shuttle housing **436**. Second handle device **434** may be configured with gripping members **446** and **448** for ease of use.

Shuttle member **444** is mounted on a rod **450** (best seen in FIG. 3C) disposed in shuttle housing **436**. Rod **450** is defined by a distal end **452** and a proximal end **454**. Distal end **452** is fixedly secured to a distal face **456** of shuttle housing **436**. Proximal end **454** is fixedly secured to a proximal face **458** of shuttle housing **436**. A biasing member **460** is positioned on rod **450** distally of shuttle **444**, so as to abut distal face **456** and a distal end of shuttle **444**. Biasing member **460** (which may be a coil spring) serves to bias shuttle **444** into a retracted position, away from distal face **456**. In one exemplary arrangement, a stop member **462** is secured to proximal end **454** of rod **450**. Stop member **462** limits the distance that shuttle **444** may be retracted by biasing member **460**. In one exemplary arrangement, actuation member **430** may be configured as a re-useable element.

Carried by, and fixedly secured to shuttle **444** is a carrier member **464**. An end view of carrier member **464** is provided in FIG. 3D. Carrier member **464** includes upwardly extending wall members **466** that flank a mounting groove **468**. Carrier member **464** extends upwardly from shuttle housing **436**.

Housing member **408** is secured to shuttle housing **436**. In one exemplary arrangement, housing member **408** includes a locking tab **470** that extends downwardly from housing member **408** and engages with a mounting groove **472** formed on a distal face **456** of shuttle housing **436**. A proximal end **474** of housing member **408** may further include a downwardly extending wall member **476** that carries a snap protrusion **478** to grip a portion of the shuttle housing **436** (see FIG. 4B).

Disposed within housing member **408** is mounting sleeve **480**. Mounting sleeve **480** comprises an elongated section **482** that is connected to a mounting section **484**. Disposed on either side of mounting section **484** are flange members **486**. Mounting section **484** is received within mounting groove **468** carrier member **464**. A distal end **488** of elongated section **482** is slidably received within a channel **485** formed in a

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mating sleeve **487**. Mounting sleeve **480** is fixedly secured to an outside surface of inner cutting cannula **416**. To insure that inner cutting cannula **416** rotates with outer cannula **402**, elongated section **482** is provided with a keyed surface that mates with a corresponding keyed surface formed in channel **484** (not shown). Thus, inner cutting cannula **416** may still selectively slide within channel **484** (and ultimately outer cannula **402**), but not rotate independently of mating sleeve **487**.

An internal hub member **490** is provided within housing member **408**. Hub member **490** has a first end fixed to rotary dial **412** and a second end fixed to mating sleeve **487**. Proximal end **406** of outer cannula **402** is secured in hub member **490**.

Formed through housing member **408** is an irrigation port **492** that is in communication with an opening **494** in the hub member **490**. In operation, irrigation (such as warm water, saline or ringers) enters into housing member **408** and into hub member **490** to deliver irrigation within the space between the inner cutting cannula **416** and the outer cannula **402**. Sealing members (not shown), such as O-rings, may be disposed in grooves **496** disposed on either side of opening **494** to insure that the irrigation is directed between outer cannula **402** and inner cutting cannula **416**.

Disposed at the proximal end of suction punch **400** is a fitting member **498** that is disposed in a fitting housing **499**. The fitting member **498** carries fitting barb **424** and is configured with mounting grooves **500** that receive seal members (not shown). As discussed above, a vacuum line **428** is connected to the fitting barb **424** to deliver vacuum to inner cutting cannula **416**. The seal members that are disposed in grooves **500** serve to insure that the vacuum is delivered to the inner cutting cannula **416**.

Inner cannula **416** may also be provided with a vent aperture **501** to provide selective venting of suction device **400**. When inner cannula **416** is retracted from tissue receiving opening **410** (as shown in FIG. 3C), vent aperture **501** is opened. However, when inner cannula **416** is in a cutting position (i.e., when distal end **418** is contacting cutting surface **422**), vent aperture **501** becomes sealed off. More specifically, in one exemplary mounting sleeve **480** is moved out of channel **485** of mating sleeve **487**, at least enough to expose venting aperture **501** that extends through both mounting sleeve **480** and inner cannula **416**. When inner cannula **416** is advanced during the cutting stroke, venting aperture **501** is received with mating sleeve **487**, distally of a sealing member (not shown) disposed in mounting grooves **503**. In this configuration full vacuum is delivered through inner cannula **416**.

During operation of suction device **400**, second handle device **434** is retracted towards first handle device **432**. This action causes shuttle **444** to move forward, against biasing member **460**. As shuttle **444** moves forward, carrier member **464** pushes against one of the flanges **486** of mounting sleeve **480**. As mounting sleeve **480** is fixedly secured to an outer surface of inner cutting cannula **416**, inner cutting cannula **416** is advanced distally within outer cannula **402** toward tissue receiving opening **410**, until distal end **420** of inner cutting cannula **416** contacts foot plate **414** of outer cannula **402**, thereby severing tissue that is disposed with tissue receiving opening **410**. Repeated retraction and releasing of second handle device **434** results in repeated cutting action.

As discussed above, to facilitate severing of tissue, vacuum is delivered to inner cutting cannula **416** through vacuum line **428**. The vacuum serves to draw tissue into tissue receiving opening **410**, as well as removing cut tissue from tissue receiving opening **410** to a collection chamber (not shown)

attached to vacuum line **428**. Continuous vacuum permits multiple severing actions to be employed with a single insertion. However, delivery of continuous vacuum may be controlled by the action of the cutting cannula. More specifically, the action of the inner cutting cannula provides for a venting action that relieves vacuum. As such, the device is particularly useful in navigating near and around critical structures within the patient so as not to inadvertently remove such structures during procedures. In addition, by providing the capability of multiple severing actions, procedure time may be reduced.

To alleviate removed tissue occluding the aspiration pathway during the cutting action, irrigation may be provided via an irrigation port **492** that is connected to an irrigation supply by an irrigation line **493**, between the inner cutting cannula **416** and the outer cannula **402**. The irrigation fluid, which may be warm water, saline, lactated ringers, or solutions intended to further enhance the biological preservation or integrity of the severed tissue may be used to flush the tissue during the procedure. To provide flexibility in accessing the soft tissue or boney tissue structure, rotation dial **412** permits the user to selectively rotate tissue receiving opening **410** to a desired location within the nasal cavity **14**.

To prevent tissue that is to be cut from slipping away from foot plate **414** when cutting cannula **416** is advanced toward foot plate **414** during the cutting stroke, a contact face **413** of foot plate **414** is provided with a textured surface that is designed to grip tissue. In one exemplary arrangement, the textured surface of foot plate **414** includes at least one serration **415** formed on contact face **413**. In one exemplary arrangement the serration **415** may be configured as a raised ramp with a proximally outwardly extending peak **417**. Peak **417** may be configured to extend substantially across the entire width of contact face **413**. However, it is understood that peak **417** need not extend across the entire width of contact face **413**. In yet another alternative and exemplary configuration, referring to FIGS. **5A-5B**, inverted serrations also be formed on foot plate **414**. Inverted serrations will be discussed in further detail below.

In yet another embodiment, a plurality of serrations **415** formed on contact face **413** that are configured as a series of raised ramps terminating at outwardly facing peaks **417**, such as, for example shown in FIG. **3E**. As discussed above, each peak **417** may be configured to extend substantially across the entire contact face **413**. Alternatively, peak **417** may be configured with interruptions such that a plurality of separate outwardly extending peaks **417** may be formed along a plane.

In another exemplary configuration, the textured surface of foot plate **414'** includes a waffle pattern that has first and second intersecting contact edges **417'** and **419**, respectively. In one exemplary arrangement, the waffle pattern is positioned on contact face **413'** such that first contact edge **417'** is oriented so as to be generally horizontal and second contact edge **419** is oriented so as to be generally vertical. However, it is understood that the disclosure is not limited to this particular configuration. Indeed, other orientations are also possible. It is further understood that the present disclosure is also not limited to the particular textured surface configurations described herein (i.e., the serrations **415** and the waffle pattern comprising first and second contact edges **417'** and **419**). Any textured surface that may operate as a gripping surface is within the scope of this disclosure.

The texture surface for foot plate **414** may be manufactured in a number of different manners. For example, textured contact surface **413/413'** may be manufactured using a material removal process such as, for example, milling, grinding, knurling, bead blasting, sand blasting or pitting. Alternatively, texture contact surface **413/413'** may be manufactured

using an additive fabrication process such as, for example, beading. Further, textured contact surface **413/413'** may be formed during a casting operation, such as sintering, stamping, investment casting, press molding, or die casting.

The textured contact surface **413/413'** permits use of the angled foot plate **414** (as may be seen in FIG. **3E**), thereby permitting foot plate **414** to be effectively used in a shoveling manner to easily and quickly get underneath tissue and/or boney material to be cut. More specifically, because contact surface **413/413'** is textured, contact surface **413/413'** serves as a grip to frictionally retain tissue and/or boney material against contact surface **413/413'** as cutting cannula **416** is advanced toward foot plate **414** during a cutting stroke. In one exemplary configuration, foot plate **414** is angled approximately 40°, although it is understood that other angled configurations are also possible.

Yet another alternative embodiment of a suction punch **400** is shown in FIGS. **4A-4K**. Suction punch **1400** includes an outer cannula **1402** defined by a distal end **1404** and a proximal end **1406** (best seen in FIG. **4F**), which is seated within a housing member **1408** (to be explained in further detail below). Distal end **1404** is open and may have an angled cutting edge **1414** to provide increased cutting effectiveness, to be explained below in further detail.

Outer cannula **1402** is configured for selective rotational movement. More specifically, a rotation dial **1412** is operatively secured to outer cannula **1402** (to be explained below in further detail). As rotation dial **1412** is rotated, distal end **1404** is also rotated, thereby allowing for easy manipulation of suction punch **1400** during procedures. Outer cannula **1402** is also configured for reciprocal movement, also to be explained below in further detail.

Referring to FIG. **4D**, disposed within outer cannula **1402** is an inner blade **1416**. Inner blade **1416** is axially fixed with respect to housing **1408**, such that it does not reciprocate. In one exemplary embodiment, (shown in FIGS. **4D** and **4F**), a proximal end **1418** of inner blade **1416** includes an attachment lip **1419** that is fixed to a portion of a saline hub **1421** (to be described in further detail below) positioned in housing **1408**. In another exemplary embodiment, proximal end **1418** may be formed with an attachment hole (not shown) that aligns with attachment passage **1420**, wherein both the attachment hole and the attachment passage receive an attachment mechanism, such as a pin.

FIG. **4H** illustrates a cross-section of inner blade **1416** taken along lines **4H-4H** in FIG. **4G**. Inner blade **1416** is defined by a top surface **1422**, a grooved surface **1424**, and a curved bearing surface **1426**. Top surface **1422** cooperates with an inner lumen **1428** of outer cannula **1402** to form a tissue passage (to be explained in further detail below). Grooved surface **1424** cooperates with inner lumen **1428** of outer cannula **1402** to form a saline passage. Positioned adjacent a distal end **1430** is a saline opening **1496** that is in communication with the saline passage. Curved bearing surface **1426** generally corresponds to the contour of inner lumen **1428**. A portion **1431** of curved bearing surface **1426** serves as a glue surface to fixedly attach inner blade **1416** to saline hub **1421**. Indeed, inner blade **1416** is fixedly secured to an inner surface of saline hub **1421**, which is mounted in housing **1408**, such that inner blade **1416** is axially fixed with respect to housing **1408**.

A distal end **1430** of inner blade **1416** includes a cutting surface or foot plate **1432** that extends upwardly from top surface **1422**. Cutting surface/foot plate **1432** cooperates with cutting edge **1414** of outer cannula **1402** to sever tissue that is received within a gap **1434** formed between distal end **1430** of inner blade **1416** and distal end **1404** of outer cannula **1402**.

Referring to FIG. 4A, housing member **1408** is mounted to an actuation member **1436**. Actuation member **1436** comprises a first handle device **1438** and a second handle device **1440**. First handle device **1438** is fixedly connected to a shuttle housing **1442**. In one exemplary configuration, shuttle housing **1442** is integrally formed with first handle device **1438**. First handle device **1438** may be configured with a thumb grip (not shown), similar to that shown in FIG. 3A (**438**).

Second handle device **1440** is pivotally connected to a shuttle member **1443** disposed within shuttle housing **1442**. Second handle device **1440** may be configured with gripping members **1444**, **1446**.

Referring to FIG. 4D, shuttle member **1443** is mounted on a rod **1448** disposed in shuttle housing **1442**. Rod **1448** is defined by a distal end **1450** and a proximal end **1452**. Distal end **1450** is fixedly secured to an interior distal face **1456** of shuttle housing **1442**. Proximal end **1452** is fixedly secured to an interior proximal face **1458** of shuttle housing **1442**. A biasing member (not shown) is positioned on rod **1448** distally of shuttle member **1443**, so as to abut distal face **1456** and a distal end **1460** of shuttle member **1443**. Biasing member (which may be a coil spring) serves to bias shuttle member **1443** into a retracted position, away from distal face **1456**. A stop member (not shown) may be secured to proximal end **1452** of rod **1448** to limit the distance that shuttle member **1443** may be retracted by the biasing member.

Carried by, and fixedly secured to shuttle member **1443** is a carrier member **1464**. Carrier member **1464** is similar to carrier member **464** shown in FIG. 3D, and includes upwardly extending wall members that flank a mounting groove. Carrier member **1464** extends upwardly from shuttle housing **1442**.

Housing member **1408** is secured to shuttle member **1443**. As best seen in FIG. 4D, in one exemplary arrangement, housing member **1408** includes a mounting flange **1470** that extends downwardly from housing member **1408**. A fastening device (not shown) is engaged through a mounting channel **1471** that extends through mounting flange **1470**. The fastening device further extends through rod **1448** to secure rod **1448** to housing member **1408**.

A proximal end **1474** of housing member **1408** further includes a downwardly extending wall member **1476** that may carry a locking tab **1478**. Locking tab **1478** engages with a mounting groove **1479** formed on a proximal face of shuttle member **1443**.

Disposed within housing member **1408** is mounting sleeve **1480**. Mounting sleeve **1480** comprises an elongated section **1482** that is connected to a mounting section **1484**. Disposed on either side of mounting section **1484** are flange members **1486** and **1486'**. Mounting section **1484** is received within a mounting groove formed on carrier member **1464**. Extending through mounting flanges **1486**, **1486'** and mounting sleeve **1480** is a passage that receives outer cannula **1402**. Outer cannula **1402** is fixedly secured within the passage. In one exemplary arrangement, outer cannula **1402** may be fixedly secured within the passage by glue. Fixedly secured to an outer surface of elongated section **1482** of mounting sleeve **1480** is rotation dial **1412**. With this arrangement, as rotation dial **1412** is rotated, mounting sleeve **1480** will rotate, as well. Further, because outer cannula **1402** is fixedly secured to mounting sleeve **1480**, as rotation dial **1412** is rotated, outer cannula **1402** will also rotate.

Referring now to FIG. 4F, saline hub **1421** will now be described. Saline hub **1421** includes an internal hub portion **1490** and an external hub portion **1492** (best seen in FIG. 4D). Saline hub **1421** is mounted to proximal end **1474** of housing

1402 such that internal hub portion **1490** is disposed within housing **1408**. A channel **1423** extends through saline hub **1421** and is in communication with an irrigation opening **1494** formed through saline hub **1421**. Channel **1423** is configured to receive outer cannula **1402**. Outer cannula **1402** is mounted within channel **1423** for sliding engagement. Inner blade **1416** is also received within channel **1423**, as described above. Inner lumen **1428** of outer cannula **1402** opens into channel **1423** at distal end **1406** of outer cannula **1402**.

Formed through housing member **1408** is an irrigation port **1493**. Irrigation port **1493** is operatively connected to an irrigation line **1495** and is in communication with irrigation opening **1494** in saline hub **1421**. In operation, irrigation (such as warm water or saline) enters into housing member **1408** and into saline hub **1421** to deliver irrigation within the space between inner blade **1416** and outer cannula **1402**, along a channel formed by grooved surface **1424** and inner lumen **1428**. Irrigation flows up through a saline opening **1496** formed in distal end **1430** of inner blade **1416** to deliver irrigation within gap **1434** between inner blade **1416** and outer cannula **1402**. Sealing members (not shown), such as O-rings, may be disposed in grooves **1491** disposed on either side of irrigation opening **1494** to insure that the irrigation is directed to the channel formed by grooved surface **1424** and inner lumen **1428** of outer cannula **1402**.

Disposed at proximal end **1474** of suction punch **1400** is a fitting member **1498** that is disposed in external hub portion **1492**. Fitting member **1498** carries a fitting barb **1499**. A vacuum line (not shown) is connected to the fitting barb **1499** to deliver vacuum to outer cannula **1402**. To insure that vacuum is delivered to outer cannula **1402**, and ultimately to a distal end **1404** of outer cannula **1402**, suction punch **1400** is provided with seal members disposed within housing **1408**. More specifically, in one exemplary arrangement, saline hub **1421** is provided with grooves **1500** disposed at a distal end thereof that receives seal members (not shown). And additional set of grooves **1502** is provided in a distal housing hub **1504** (shown in FIG. 4D). Distal housing hub **1504** is mounted in a first mounting portion **1506** of housing **1408**. First mounting portion **1506** further includes a distal chamber **1508** and a proximal chamber **1510**. Distal housing hub **1504** is mounted in distal chamber **1508**. Proximal chamber **1510** is configured to receive a distal sealing end **1512** of mounting sleeve **1480**. A mounting groove **1513** is formed between distal sealing end **1512** and flange member **1486'**. Mounting groove **1513** receives a sealing member (not shown) such as an O-ring. In one embodiment, positioned adjacent to mounting sleeve **1480** is a venting aperture **1514** (best seen in FIG. 4E). Venting aperture **1514** extends through a sidewall of outer cannula **1402**.

During operation of suction device **1400**, second handle device **1440** is retracted towards first handle device **1438**. This action causes shuttle member **1443** to move forward, against the biasing member. As shuttle member **1443** moves forward, carrier member **1464** pushes against one of the flanges **1486'** of mounting sleeve **1480**. Because mounting sleeve **1480** is fixedly secured to an outer surface of outer cannula **1402**, outer cannula **1402** is advanced distally over inner blade **1416**, until distal end **1404** of outer cannula **1402** contacts cutting surface **1432** of inner blade **1416**, thereby severing tissue that is disposed with gap **1434** defined between inner blade **1414** and distal end **1404** of outer cannula **1402** (see FIG. 4B). Repeated retraction and releasing of second handle device **1440** results in repeated cutting action.

To facilitate collection of tissue, vacuum is delivered to outer cannula **1402** through a vacuum line attached to fitting barb **1499**. The vacuum serves to draw tissue into outer can-

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nula 1402, as well as remove cut tissue to a collection chamber (not shown) attached to the vacuum line. Continuous vacuum permits multiple severing actions to be employed with a single insertion. However, delivery of continuous vacuum may be controlled by the action of the cutting cannula. More specifically, the action of the inner cutting cannula provides for a venting operation that relieves vacuum. As such, the device is particularly useful in navigating near and around critical structures within the patient so as not to inadvertently remove such structures during procedures. In addition, by providing the capability of multiple severing actions, procedure time may be reduced.

To alleviate removed tissue occluding the aspiration pathway during the cutting action, irrigation may be provided via an irrigation port 1493 that is connected to an irrigation supply by irrigation line 1495, between inner blade 1416 and outer cannula 1402. The irrigation fluid, which may be warm water or saline, can flow up through opening 1496 in inner blade 1416. Such fluid serves to flush the tissue during the procedure. To provide flexibility, such as to access turbinates 12 in an endonasal procedure, rotation dial 1412 permits the user to selectively rotate inner blade 1416 and outer cannula 1402 to a desired location within a body cavity.

Suction punch 1400 may also provide vacuum relief during operation. During the cutting stroke, as second handle device 1440 is actuated and distal end 1404 of outer cannula 1402 is moved toward cutting surface 1432 of inner blade 1416, distal sealing end 1512 of mounting sleeve 1480 moves into proximal chamber 1510 of first mounting portion 1506 until flange member 1486' abuts first mounting portion 1506, with a sealing member (disposed within mounting groove 1513) contacting an inner surface of proximal chamber 1510. Venting aperture 1514, which is positioned distally of distal sealing end 1512, is thus sealed off while outer cannula 1402 is engaged with cutting surface 1432 of inner blade, providing full vacuum to deliver severed tissue through outer cannula 1402.

To provide vacuum relief, as second handle device 1440 is returned to its non-actuated position (i.e., away from first handle device 1438) by the biasing member, distal sealing end 1512 of mounting sleeve 1480 is moved out of proximal chamber 1510, thereby allowing vacuum delivered through outer cannula 1402 to vent through vent aperture 1514.

Turning to FIGS. 4I-4K, partial illustrations of an alternative configuration of a suction punch 1600 are shown. Suction punch 1600 is very similar to suction punch 1400 and includes an outer cannula 1602 that is configured similar to outer cannula 1402. Outer cannula 1602 is defined by a distal end 1604 and a proximal end 1606 (see in FIG. 4K), which is seated within a housing member similar to housing member 1408. Distal end 1604 is open and may have an angled cutting edge 1614 to provide increased cutting effectiveness. Outer cannula 1602 is configured for both selective rotational movement and reciprocal movement by an actuation assembly, as described above in connection with suction punch 1400.

Disposed within outer cannula 1602 is an inner cannula 1616. In the configuration shown in FIG. 4I, inner cannula 1616 replaces inner blade 1416. Inner cannula 1616 is axially fixed with respect to the housing, such that it does not reciprocate. In one exemplary arrangement, a portion of a proximal end 1619 of inner cannula 1616 includes an outwardly extending mounting member that may be received within a portion of a saline hub 1621 positioned in housing 1608 (see, e.g., FIG. 4K). In one configuration, the mounting member is received within a mounting groove 1620. The mounting member may be secured within mounting groove 1620 with

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glue to fixedly attach inner cannula 1616 to housing 1408. A portion of an outer surface of inner cannula 1616 may serve as a glue surface to fixedly attach inner cannula 1616 to a portion of an inner surface 1622 of saline hub 1621, which is mounted in housing 1408, such that inner cannula 1616 is axially fixed with respect to housing 1408.

Inner cannula 1616 further is defined by a distal end 1630, which includes a cutting surface/foot plate 1632 disposed on a tip 1633 thereof. A tissue receiving opening 1635 is formed adjacent tip 1633. Cutting surface/foot plate 1632 cooperates with cutting edge 1614 of outer cannula 1602 to sever tissue that is received within tissue receiving opening 1635. Tissue receiving opening 1635 opens into a tissue passage 1637. Tissue passage 1637 is operatively connected to a vacuum supply. Vacuum supply operates to deliver severed tissue through the housing and to a collection canister.

Fixedly disposed within inner cannula 1616 is an irrigation supply tube 1639. In one exemplary configuration, irrigation supply tube 1639 is positioned along a bottom portion of inner cannula 1616 and has a distal end 1640 that is positioned adjacent cutting surface 1632. A proximal end 1634 of irrigation supply tube 1639 is in fluid communication with an irrigation opening 1694 disposed within saline hub 1621. More specifically, irrigation supply tube 1639 includes an opening 1636 formed in a sidewall that aligns with a corresponding opening 1638 formed inner cannula 1616. While irrigation supply tube 1639 is shown as being positioned along a bottom portion of inner cannula 1616, it is understood that the disclosure is not limited to that configuration. For example, and without limitation, irrigation supply tube 1639 may also be positioned along a top portion of inner cannula 1616 such that distal end 1640 is positioned at tissue opening 1635.

Referring now to FIG. 4K, saline hub 1621 will now be described. Saline hub 1621 includes an internal hub portion 1690. Saline hub 1621 is mounted to a proximal end of housing 1402 such that internal hub portion 1690 is disposed within housing 1408. A channel, defined by inner surface 1622 of saline hub 1621 extends through saline hub 1621. The channel is configured to receive outer cannula 1602. Outer cannula 1602 is mounted within the channel for sliding engagement. Inner cannula 1614 is also received within the channel, as described above.

Formed through housing member 1608 is an irrigation port 1693. Irrigation port 1693 is operatively connected to an irrigation line and is in communication with irrigation opening 1694 in saline hub 1621. In operation, irrigation (such as warm water or saline) enters into housing member 1608 and into saline hub 1621 to deliver irrigation to irrigation supply tube 1639. To direct irrigation fluid into irrigation supply tube 1639, sealing members (not shown), such as O-rings, may be disposed in grooves 1691, 1695 disposed on either side of irrigation opening 1694. More specifically, grooves 1691 are disposed in an outer surface of saline hub 1621 such that a sealing member disposed therein serves to prevent irrigation fluid from entering between saline hub 1621 and housing 1608. Grooves 1695 are disposed in inner surface 1622 of saline hub 1621 such that a sealing member disposed therein serves to prevent irrigation fluid from entering between inner and outer cannulas 1616, 1602.

Turning now to FIGS. 4L-4N, to prevent tissue that is to be cut from slipping away from foot plates 1432/1632 when cutting cannula 1402/1602 is advanced toward foot plate 1432/1632 during a cutting stroke, a contact face 1413/1613 of foot plate 1402/1602 is provided with a textured surface that is designed to grip tissue, similar as to that which was described above in connection with FIGS. 3E-3G. More spe-

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cifically, in one exemplary arrangement, the textured surface of foot plate **1432/1632** includes a plurality of serrations formed on contact face **1413/1613** that are configured as a series of ramp-like members terminating at outwardly facing peaks **1417/1617**, such as, for example shown in FIG. 4L. In another exemplary configuration, the textured surface of foot plate **1432/1632** includes a waffle pattern that has first and second intersecting contact edges **1415/1615** and **1419/1619**, respectively. In one exemplary arrangement, the waffle pattern is positioned on contact face **1413'/1613'** such that first contact edge **1415/1615** is oriented so as to be generally horizontal and second contact edge **1419/1619** is oriented so as to be generally vertical. However, it is understood that the disclosure is not limited to this particular configuration. Indeed, other orientations are also possible.

It is further understood that the present disclosure is also not limited to the particular textured surface configurations described herein (i.e., the serrations comprising ramp-like members terminating at outwardly facing peaks **1417/1617** and the waffle pattern comprising first and second contact edges **1415/1615** and **1419/1619**). Indeed, any textured surface that may operate as a gripping surface is within the scope of this disclosure. For example, referring to FIGS. 5A-5B, a contact face **2413** of foot plate **2432** may be provided with a plurality of inverted serrations formed on contact face **2413**. Inverted serrations that are also configured as a series of ramp-like members, but ramp-like members terminate at inwardly facing valleys **2417**, such as, for example shown in FIG. 5A. In yet another alternative arrangement, referring to FIGS. 6A-6B, contact face **2432'** of foot plate **2432'** may be provided with a plurality of inwardly extending grooves **2417'** that are separated from one another by land members **2416**, such as, for example shown in FIGS. 6A-6B.

In yet another alternative arrangement, shown in FIGS. 7A-7B, textured surface of contact face **3413** of foot plate **3432** may be formed by the use of a coarse grit coating, such as by sand blasting. While FIGS. 7A-7B illustrate only the coarse grit coating being used on contact face **3413**, it is understood that in another exemplary arrangement, the coarse grit coating may be used with any other embodiments shown in FIGS. 4L-4N, 5A-5B and 6A-6B.

The textured surface for foot plate **1432/1632/2432/2432'** may be manufactured in a number of different manners. For example, textured contact faces **1413/1613/2413** and **1413'/1613'/2413'** may be manufactured using a material removal process such as, for example, milling, grinding, knurling, bead blasting, sand blasting or pitting. Alternatively, texture contact surfaces **1413/1613/2413** and **1413'/1613'/2413'** may be manufactured using an additive fabrication process such as, for example, beading. Further, textured contact surfaces **1413/1613/2413** and **1413'/1613'/2413'** may be formed during a casting operation, such as sintering, stamping, investment casting, press molding, or die casting.

The textured contact surfaces **1413/1613** and **1413'/1613'** permit use of the an angled foot plate **1432/1632** (as may be seen in FIGS. 4B and 4I), thereby permitting foot plate **1432/1632** to be effectively used in a shoveling manner to easily and quickly get underneath tissue and/or boney material to be cut. More specifically, because contact surfaces **1413/1613** and **1413'/1613'** are textured, contact surfaces **1413/1613** and **1413'/1613'** serve as a grip to frictionally retain tissue and/or boney material against contact surfaces **1413/1613** and **1413'/1613'** as outer cannulas **1402/1602** are advanced toward foot plate **1432/1632** during a cutting stroke. In one exemplary configuration, foot plates **1432/1632** are angled approximately 40°, although it is understood that other angled configurations are also possible.

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It will be appreciated that the system and methods described herein have broad applications. The foregoing embodiments were chosen and described in order to illustrate principles of the methods and apparatuses as well as some practical applications. The preceding description enables others skilled in the art to utilize methods and apparatuses in various embodiments and with various modifications as are suited to the particular use contemplated. In accordance with the provisions of the patent statutes, the principles and modes of operation of this invention have been explained and illustrated in exemplary embodiments.

It is intended that the scope of the present methods and apparatuses be defined by the following claims. However, it must be understood that this invention may be practiced otherwise than is specifically explained and illustrated without departing from its spirit or scope. It should be understood by those skilled in the art that various alternatives to the embodiments described herein may be employed in practicing the claims without departing from the spirit and scope as defined in the following claims. The scope of the invention should be determined, not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. It is anticipated and intended that future developments will occur in the arts discussed herein, and that the disclosed systems and methods will be incorporated into such future examples. Furthermore, all terms used in the claims are intended to be given their broadest reasonable constructions and their ordinary meanings as understood by those skilled in the art unless an explicit indication to the contrary is made herein. In particular, use of the singular articles such as "a," "the," "said," etc. should be read to recite one or more of the indicated elements unless a claim recites an explicit limitation to the contrary. It is intended that the following claims define the scope of the invention and that the method and apparatus within the scope of these claims and their equivalents be covered thereby. In sum, it should be understood that the invention is capable of modification and variation and is limited only by the following claims.

What is claimed is:

1. A tissue cutting device, comprising:

a housing;

a cutting member partially supported within the housing, the cutting member defined by an open distal end and an open proximal end, the cutting member operatively connected to an actuator assembly;

a hollow non-reciprocating base member partially supported within the housing, the hollow non-reciprocating base member defined by an open proximal end and having a hollow tissue pathway defined between a distal end of the hollow non-reciprocating base member and the open proximal end, having an upwardly extending foot plate disposed on the distal end thereof, the base member configured for selective rotation with respect to the housing;

wherein the cutting member is configured for reciprocating movement with respect to the distal end of the hollow non-reciprocating base member;

wherein the cutting member is received over the hollow non-reciprocating base member and is configured for selective rotational movement with respect to the housing;

wherein a distal end of the cutting member has a cutting element and the distal end of the cutting member and the foot plate cooperates to define a tissue receiving opening;

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wherein the foot plate defines a contact surface that is configured with a textured surface that serves as a grip to operatively retain material to be cut when the cutting member is moved toward the foot plate; and

wherein when the cutting element of the cutting member is moved against the foot plate to sever tissue, the tissue that is severed is delivered through the hollow tissue pathway and out the proximal end of the hollow non-reciprocating base member to exit the housing by application of vacuum to the proximal end of the hollow non-reciprocating base member.

2. The tissue cutting device of claim 1, wherein the foot plate is oriented such that the foot plate is angled with respect to a horizontal axis extending through the hollow non-reciprocating base member in a distal direction by a predetermined amount.

3. The tissue cutting device of claim 2, wherein the foot plate is angled by approximately 40 degrees from a horizontal axis extending through the hollow non-reciprocating base member.

4. The tissue cutting device of claim 1, wherein the textured surface is configured as at least one serration that defines at least one extending peak.

5. The tissue cutting device of claim 4, wherein the at least one peak is configured to extend proximally from the contact surface.

6. The tissue cutting device of claim 4, wherein the at least one serration is inverted such that the at least one peak extends inwardly from the contact surface.

7. The tissue cutting device of claim 4, wherein the textured surface is configured with a plurality of serrations, each serration defined by a peak.

8. The tissue cutting device of claim 4, wherein the peak is oriented so as to be generally horizontal with respect to the contact surface.

9. The tissue cutting device of claim 7, wherein each peak extends across the width of the foot plate.

10. The tissue cutting device of claim 7, wherein each peak is discontinuous across the width of the foot plate.

11. The tissue cutting device of claim 1, wherein the textured surface is configured to include at least one groove formed in the contact surface.

12. The tissue cutting device of claim 11, wherein the textured surface is configured with a plurality of grooves formed in the contact surface, wherein each groove is separated by a land member.

13. The tissue cutting device of claim 1, wherein the textured surface is formed using a material removal operation.

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14. The tissue cutting device of claim 13, wherein the material removal operation is one of milling, grinding, knurling, bead blasting, sand blasting and pitting.

15. The tissue cutting device of claim 1, wherein the textured surface is formed using a casting operation.

16. The tissue cutting device of claim 15, wherein the casting operation is one of sintering, stamping, investment casting, press molding, and die casting.

17. The tissue cutting device of claim 1, wherein the textured surface is formed by a beading operation.

18. The tissue cutting device of claim 1, wherein the textured surface is configured as waffle pattern that is defined by a plurality of first and second proximally extending intersecting contact edges.

19. The tissue cutting device of claim 18, wherein the first contact edges are oriented to extend generally horizontally and the second contact edges are oriented to extend generally vertically.

20. The tissue cutting device of claim 18, wherein the waffle pattern is formed using a material removal operation.

21. The tissue cutting device of claim 20, wherein the material removal operation is one of milling, grinding, knurling, bead blasting, sand blasting and pitting.

22. The tissue cutting device of claim 18, wherein the waffle pattern is formed using a casting operation.

23. The tissue cutting device of claim 22, wherein the casting operation is one of sintering, stamping, investment casting, press molding, and die casting.

24. The tissue cutting device of claim 18, wherein the waffle pattern is formed by a beading operation.

25. The tissue cutting device of claim 1, wherein the textured surface is configured as a coarse grit coating that is applied to the contact face.

26. The tissue cutting device of claim 4, further including a coarse grit coating applied to the contact face, including the at least one serration.

27. The tissue cutting device of claim 11, further including a coarse grit coating applied to the contact surface, including the at least one groove.

28. The tissue cutting device of claim 18, further including a coarse grit coating applied to the contact surface, including the first and second proximally extending intersecting contact edges.

29. The tissue cutting device of claim 1, further comprising an irrigation supply tube positioned along a portion of the hollow non-reciprocating base member, wherein the irrigation supply tube includes a distal end that is positioned adjacent the contact surface.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

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INVENTOR(S) : Joseph L. Mark et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 16, Claim 25, line 32, please change [[face]] to --surface--.

Column 16, Claim 26, line 34, please change [[face]] to --surface--.

Signed and Sealed this
Thirtieth Day of June, 2015

A handwritten signature in black ink, reading "Michelle K. Lee". The signature is written in a cursive, flowing style.

Michelle K. Lee
Director of the United States Patent and Trademark Office